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Thresholds 42: Human

Edited by Tyler Stevermer

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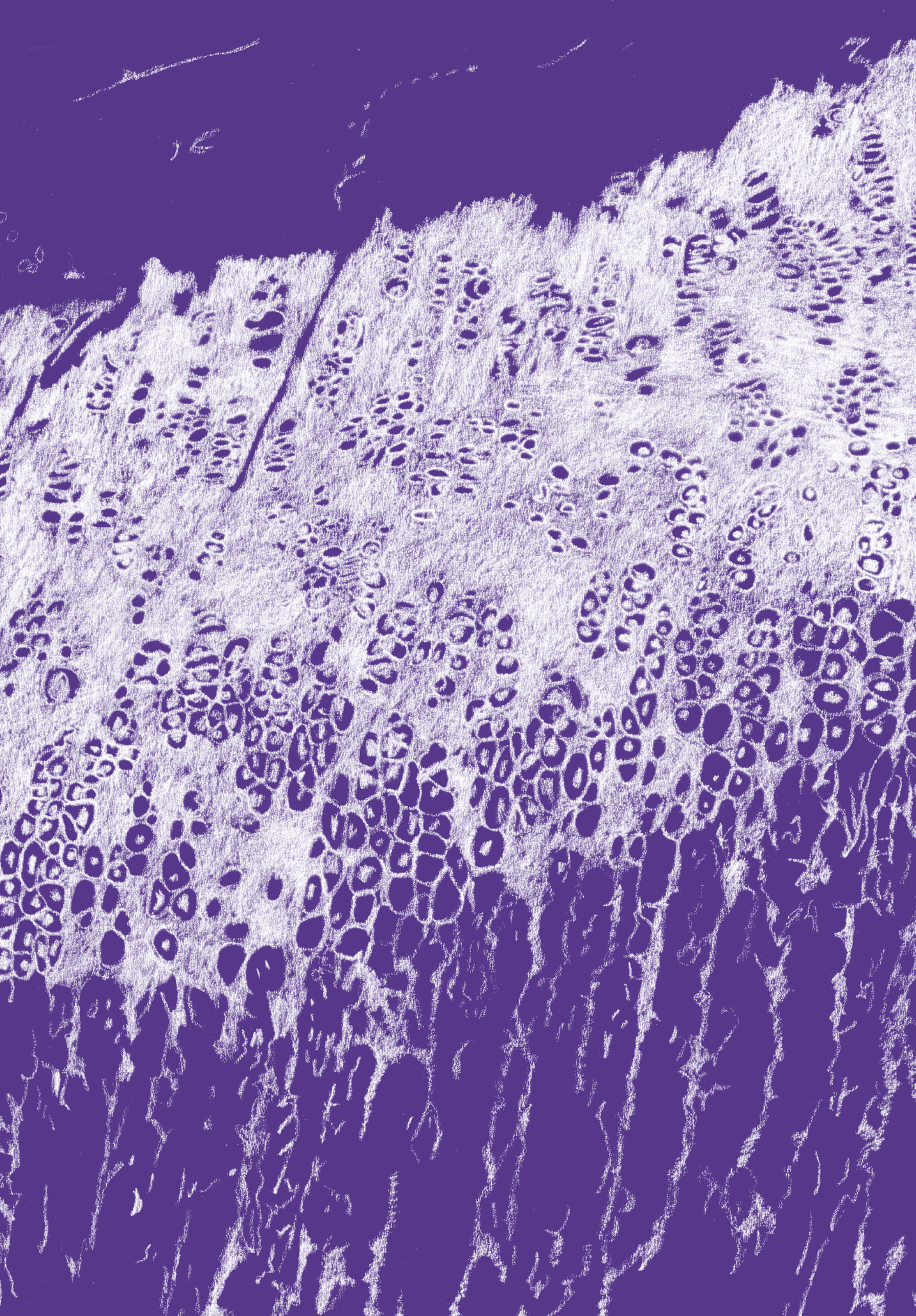

Thresholds 42
Human

Special thanks to
Irene Hwang

Editorial Policy

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INTRODUCTION
TYLER STEVERMER

One could argue that the bulk of our contemporary built environment is shaped primarily by forces that have little to do with humans as a species. Most of our habitats now meet, what could be viewed, as the lowest common denominator of occupancy so that other agendas (be they economic, political, social, or theoretical) may be achieved.

But, what constitutes an architecture that meaningfully engages with the human and its processes? Do *Homo sapiens* have specific habitat requirements or preferences? Is architecture powerful enough to guide the course of evolution? What counts as technology and how does it shape the species?

In the last decade innovations in cognitive imaging, computer interfaces, communication technologies, surrogate natures, sensory mediators, and global tracking have reshaped our understanding of the self. Can this shift inform new approaches in occupant-based design or are we still pushing towards an enlightenment-based, rationalist perspective of the human as a neurobiological mechanism? Do the technologies of our time continue to force us into a deterministic and mechanistic view of both occupants and design or have we formed new gateways of artistic and architectural possibility?

I've chosen the term 'human' for four reasons: [1] it quantifies an individual versus a group; [2] it connotes that one could aspire to place this individual into a generalizable and scientifically objective definition; [3] the term is vague enough to allow this definition to be stretched, examined, explored, and modified between authors; and [4] it carries with it a sensitive baggage of ethics that requires both boldness and caution to probe.

Thresholds issue 42 engages authors to define 'human' and consider the species with regards to its physical, virtual, and psychological habitat. As many of our authors will argue through various discourses, it's impossible for an organism to not be affected by its environment. If this is indeed the case, should the architect not consider the inhabitant of the environments they create? Rather than leaving the influence of the built environment to chance, the contents of this issue suggest that the architect has the opportunity (and perhaps the obligation) to choreograph this encounter with intent.

The texts included provide histories, theories, and creative proposals to guide this conversation. They seek what it means to be 'human' and investigate what happens when the environment acts as mediator for biological processes.

The first section of articles argues that being human requires engagement with technology, from simple tools to language, writing and (of course) architecture.

Mark Jarzombek starts with a historiography of the attitudes and scientific biases that created the classification *Homo sapiens*, while speculating on how this term can evolve. He urges us to avoid civilization-centrism in our presumptions of early societies and suggests that, in many instances, the only thing differentiating "advanced" peoples is a range of technological (rather than biological) evolutions. With these lessons in mind, **Timothy Cook** and **Andrew Ferentinos** present us with a selection of drawings from the exhibition "Beginnings: Drawing Early Architecture," in conjuncture with Jarzombek. These drawings expose the urban and domestic forms of early societies, allowing us to consider the architectural technologies of what is commonly considered "vernacular" building as well as the forces that shaped these early human environments.

Ginger Nolan interweaves histories from Plato to Papert, investigating knowledge acquisition theories while explaining language and writing as technologies that simultaneously transcribe and limit human truths. She examines how these theories came to be tested in early 19th century France (in a famous experiment on a "primitive" mind) and later, in the 1980s, at the Media Lab (in the blank slate of the computer).

The next section continues showcasing how technology can bring to light imperceptible processes that, nonetheless, force us to reconsider what qualifies as human. **Stephan Helmreich** investigates how the findings of the Human Microbiome Project provoke a reconceptualization of the human body to include, what he terms, the "symbiopolitics" of our microbial ecologies. He questions the classification *Homo sapiens* in favor of *Homo microbis,* which recognizes the impact and importance microbial organisms play in the body and genome.

Mariel Villeré introduces the work of Sonja Bäumel, whose conceptual projects offer different ways to perceive and identify with the microbial body through design. Villeré interprets the work of Bäumel, which emerges from the body

of the artist, as blurring the relationship between *Homo faber* (man the maker) and the item that is made. **Simone Ferracina** is also creatively pursuing how to expose imperceptible aspects of human life. His fictitious, cybernetic nanobots share visualizations that allow individuals to intimately reshape their self-understanding as well as the human potential around them.

Ferracina's fiction leads us into the potential realities of designing around cognitive processes. **Harry Francis Mallgrave** unpacks the experience of architecture from a neurobiological perspective, challenging architectural theory's adherence to representation rather than rationalizing itself through experience. In considering the metrics for this type of work, we move to **Krister Holmes'** history of the electroencephalogram (EEG). Holmes regales us with a story of how the creator of the now-conventional device was at odds with the psychological discourse of his time.

Our fourth section focuses on themes of homeostasis and medicine. **Caroline A. Jones** interviews **Michael Hagner** and together they explore Georges Canguilhem's writings on medicine and health. Topics include questioning the analogization of organism and society, defining auto-correction and self-regulation in living beings, and exploring human use of medicine and our species-specific interest in our own decline.

Sofia Lemos and **Nick Axel** initiate a discussion on architecture's potential as medicine. Similar to Mallgrave's request for an architecture based on the neurobiology of experience, Lemos and Axel explore architecture that engages with our genome. The authors lay out several recent precedents that demonstrate approaches for the use of bioinformatics as a basis of design, ranging from abstract representation to architecture that dynamically engages with the occupants' biology. **Matt Johnson** and **Ryan R. Ludwig** continue this inquiry in each of their pieces, which speculate on architecture's ability to inform physiological and evolutionary processes. Johnson reads buildings as an extension of the body's attempt to thermoregulate and maintain homeostasis. Meanwhile, Ludwig focuses on genetic theory to see how creating active environments, which challenge this homeostasis, could encourage human development and evolution.

If the previous section probes the idea that environmental design can be used to prompt human evolution, the final section may ask to what end? **Jillian Crandall** writes a fiction that imagines performance-enhancing prosthesis, as well as devices that record and share experiences, breaking apart the architecture of spectacle while enveloping global urban landscapes. Her work raises questions about the purpose and anatomical boundaries of the body within athletic events.

Elliot Sturtevant reminds us of a classic example of modernism's interest in mechanically increasing human productivity by looking at the work of American industrialists, the Gilbreths. He traces their attitudes towards human anatomy, as a carefully regulated resource for work, through their time and motion metrics and their apparatuses that fuse man and mechanism. **Jenny Hall** then studies the outcome of this mindset, as it moved through time and culture, in her field investigations of machines in the contemporary production of traditional Japanese handcrafts. Hall seeks to uncover shifts within long-held concepts of the self-product interface when new machine processes become embedded. She asks, in order to maintain the schema of products as an embodiment of its creator's spirit, does technology become an extension of the body or must the spirit instead be embodied within the technology?

This issue of *Thresholds* concludes with the artwork of **Alissa van Asseldonk** who exposes existing markets that use human tissue as raw material. She carefully documents the processes of tissue harvesting and follows their economic channels.

Although the selected submissions have been arranged based on sub-topics, each piece could potentially inhabit several of these realms and also inform each other. It's my hope that they speak in dialogue with each other in order to postulate possible futures for the human as a driving force within architecture.

section one

technology

ARE WE *HOMO SAPIENS* YET?
MARK JARZOMBEK

!Kung being photographed for a documentary.

From Sapiens To Hunter/Gatherers

We may appreciate the Enlightenment-era optimism about our intrinsic epistemological capacity, but when the Swedish botanist Carolus Linnaeus (1707 - 1778) coined the term *Homo sapiens*, this was not the Socratic mandate to know thyself. Instead our "knowledge" belonged to a complex classificatory tree, the smallest element of which was a species and its 'varieties'. It was a revolution just as significant as Darwin's theory of evolution some hundred years later. Linnaeus' Man was not a creature of the Bible tortured by the perplexing duality of body and spirit, but an animal, one of the thousands, that populates the world. And yet, *Homo sapiens* had a special gift, for it alone sees that everything fits into a single, vast *Imperium*. The argument was the perfect and perhaps somewhat frightening fusion of reason and empire.

Imperium - the phenomenal world
Regnum - the division of nature into animal, vegetable, and mineral.
Classis - the subdivisions of the above; in the animal kingdom, six were recognized (mammals, birds, amphibians, fish, insects, and worms)
Ordo - the subdivision of the above - the class Mammalia has eight, including Primates
Genus - the subdivisions of the order - in the order Primates there are four. One of which is *Homo*
Species - the subdivisions of genus, e.g. *Homo sapiens*.
Varietas - the species variant, e.g. *Homo sapiens europaeus*.

As it turns out *Homo sapiens* was not a particularly stable category.[1] In the 1735 first edition of *Systema*, distinctions were based on color. But in the 1766 edition, Linnaeus changed his mind and divided *Homo* into categories that reflect the increased contact with non-European people.

1735
Sapiense europaeus albus (white)
Americanus rubescens (red)
Asiaticus fuscus (brown)
Africanus niger (black)

1766
Europaeus (regulated by law)
Americanus (regulated by custom)
Asiaticus (regulated by opinion)
Afer (African, governed by caprice)
furus (wild)
monstrosus
troglodytes (nocturnal people)

Just as the lower animals were governed by instinct, *sapiens* were now bound to one of four social frameworks: custom, law, opinion and caprice. Among the four, *Homo sapiens europaeus* still reigned supreme since he alone was governed by law. Linnaeus also expanded the geographical reach of his humans. There were now also three sub categories. Troglodytes - or what we would today call 'cave men' – were regulated by the sun and moon. Whereas the Wild People (*furus*), or what we might call the Eskimos, were the most unregulated of all.

Though today *Homo sapiens europaeus* has silently slipped into the waters of historical amnesia, the word *Homo sapiens* has most certainly not. But its stability is hardly assured and indeed it might be good to remind ourselves just how difficult it was to identify humankind's claim of self-knowledge. In 1802, William Turton, an English naturalist whose specialty was sea shells - and a member of the society - translated Linnaeus' work from the Latin into English, but kept, of course, the famous term. And it stuck. However, whereas Linnaeus focused on what regulates humans, Turton gave his *sapiens* psychological characteristics. The metaphys-

1 Philip Sloan, "The Gaze of Human Nature," *Inventing Human Science: Eighteenth-century Domains*, Edited by Christopher Fox, Roy Porter, Robert Wokler (Berkeley: University of California Press, 1995), 124.

ics of law and geography was replaced by a metaphysics of personality types.

Americans: copper-colored, irritable, erect
Europeans: fair, sanguine and brawny
Asiatics: sooty, melancholy and rigid
Africans: black, phlegmatic and relaxed[2]

The shift from social custom to psychology reaffirmed the colonial superiority to the *Homo sapiens europaeus*, while acknowledging that that superiority might have more to do with brawniness than with the rule of law. This was not the last transformation. Thomas Henry Huxley (1825-1895) divided the dark whites from the blond whites, and the Spaniards from the Berbers and Swedes. Joseph Deniker, a French anthropologist (1852-1918) went even further, making thirteen divisions yielding 29 races, one of which, and his most lasting contribution to the field of racial theory, was the designation, *la race nordique,* which for him replaced *Homo sapiens europaeus*. By the 1920s there were *Homo sapien bushmen* and *Homo sapiens dravidicus* (Indians) and so forth. In 1950, even the authorities at UNESCO waded into the issue and announced in their "Statement on Race" that there were just three divisions of *Homo sapiens*, namely Mongoloid, Negroid and Caucasoid with many unspecified subgroups.[3] Clearly this did not help. The term Caucasian turned out to be complex and ambiguous. But it was only in 2005, that the United States National Library of Medicine finally decided to replace it with "European Continental Ancestry Group."[4]

To avoid the problem of race, anthropologists turned to geography, as in a species that was discovered in 2010, that was named *Homo gautengensis* after an archaeological site in South Africa, namely Gautenag. The same logic is true for *australopithecus africanus* ("southern ape of Africa"), *Homo floresiensis* (named after the island of Flores), the *Homo neanderthal* (named after a valley in Germany), and *Homo heidelbergensis* (named after a city in Germany).[5] Simultaneously there was an attempt to push back the point at which *Homo sapiens* emerged historically to make the category more – shall one say - inclusive. The result was that *Homo heidelbengsis* was no longer a hulking predecessor to *Homo sapiens,* but itself a *Homo sapiens*! And the *Homo sapiens*, in order to be differentiated from its hominoid cousins, were now called *Homo sapiens sapiens*. This subspecies (namely you and me) began to be used in the 1950's by scholars like Ernst Mayr, George Simpson and Theodosius Dobzhansky and it was related to their shared view that *sapiens* represented a polytypic species meaning that the various genetically isolated populations of early humans arose as local differentiations of a single stock. This position stands in opposition to polyphyletic models of modern human origins, which argues that there were several 'beginnings' not just one. Regardless of the scholarly point, the bizarre doubling of our knowledge-carrying capacity is what now differentiates us from our Neanderthal predecessors.

The irony of all this is that if we turn to anthropology, which claims to see our ancient past not through the lens of abstract categories, but through the ostensible realities of flesh and blood, our ancient ancestors were what they called "hunter-gatherers." The term is not an old one, but appeared in the early 1970s, more or less at the same time that *Homo sapiens* became *Homo sapiens sapiens*.[6] It was adopted with almost no criticism in the rising tide of anthropological studies. There is a whole encyclopedia, published by Cambridge University Press in 1999 that is dedicated to "hunter-gatherers."[7] The *Homo sapiens* went from being the high arbiter of reason, to a creature groveling around for food, a tuber or two away from starvation.

Some anthropologists now admit that it was wrong to identify ancient cultures solely with food acquisition. Most of the time spent by ostensible "hunter-gatherers" is not in hunting and gathering, but in activities of social cohesion.

2 Carl von Linné, William Turton, *A General System of Nature,* Vol. 1 (London: Allen and Co., 1806), 9.
3 Ashley Montagu, "The Race Question: Statement issued 18 July 1950," 5. http://unesdoc.unesco.org/images/0012/001282/128291eo.pdf
4 http://www.nlm.nih.gov/pubs/techbull/nd03/nd03_med_data_changes.html [accessed June 2, 2013] See also: Bruce David Baum, *The Rise and Fall of the Caucasian Race: a Political History of Racial Identity* (New York NY: New York University Press, 2006), 64-67.
5 This followed the dictum of Frank Livingstone, who wrote, "There are no races, there are only clines," invoking a word coined in 1938 to describe geographical gradients of features in natural populations. Frank Livingstone and Theodosius Dobzhansky, "On the Non-Existence of Human Races," *Current Anthropology* 3 (1962), 279 (279–281).
6 For a review of the disciplinary problems associated with research into hunter/gatherers see Peter Mitchell, "Hunters and Gatherers," The Oxford Handbook of Archaeology, Edited by Barry Cunliffe, Chris Gosden, Rosemary A. Joyce, (Oxford: Oxford University Press, 2009), 411-416.
7 *The Cambridge Encyclopedia of Hunters and Gatherers*, Richard B. Lee and Richard Daly, editors. (Cambridge: Cambridge University Press, 1999)

Naturally, food collecting is an important activity, but remarkably the majority of the time spent by the !Kung, for example, is spent in other pursuits, such as resting in camp or visiting other camps. Women spend their time preparing food, doing embroidery, visiting other camps, or entertaining visitors from other camps. The men go on hunts, but their schedule is unpredictable and subject to magical control. During periods when there is no hunt, the men spend time visiting, entertaining, dancing and preparing their bows and arrows.[8] The life of the !Kung cannot be considered completely identical to those of ancient times, but at least it shows that a well-positioned camp close to water, nut-bearing trees, animal habitats and other human settlements was more stable, orderly and complex than was assumed even a few decades ago.

So why this emphasis on food acquisition since it brings us back to statements like the following from 1870?

> *Care for his natural wants must have absorbed his whole being; all his efforts must have tended to one sole aim – that of insuring his daily subsistence.*[9]

I suspect that the sudden appearance of "hunter-gatherers" in the 1970s had something to do with the so-called War on Hunger. The World Food Council, after all, was created in 1974. Coincidently, the !Kung in Africa appeared on the anthropological map in the early 1970s and quickly became the poster child for the new category. Anthropologists were eventually amazed to figure out that the !Kung had lived in the Kalahari Desert quite comfortably for a hundred thousand years.[10] Studies have made it clear that when so-called hunter-gatherers encountered agriculturalists many adapted; but others did not fundamentally change their way of life. For them, the world was in essence already "farmed." All that needed to be done was the harvesting. During his study of the !Kung, the anthropologist, Richard Lee, when he asked the people why they did not farm, received the reply, "Why should I farm when there are so many mongongo nuts?[11] The Aboriginal Australians put it in similar terms.

> *You people go to all that trouble, working and planting seeds, but we don't have to do that. All these things are there for us; the Ancestral Beings left them for us. In the end, you depend on the sun and the rain just the same as we do, but the difference is that we just have to go and collect the food when it is ripe. We don't have all this other trouble.*[12]

These quick frays into the historiography of our ancient past should remind us that even though we might today think that we have moved past centuries of biases, this is not the case. We might have removed some of the more obvious aspects of bias, but we have not removed our civilizational hubris. We have no shame in calling the !Kung hunter-gatherers, when even we do not spend all our time in the super markets and would find it laughable if Cambridge University Press was to write an encyclopedia entitled "Super Market People." And yet, in the 1980s, we placed our ancestors on an astonishingly low plane of existence at the very same time that the Linnaeans were elevating our intelligence to the point of absurdity. Just as it is a disciplinary disgrace to call the !Kung or for that matter any early society hunter-gatherers, I would prefer it if the scientists would not label us *homo sapiens sapiens.* We certainly haven't earned it.

The Precursor Paradox

Neither *Homo sapiens* nor "hunter-gatherers" are historical categories. Both are timeless conditions and it is thus easy to critique these concepts as falsifications. But the problem is not resolved if one turns to the question of history. The introduction of historical time was, of course, one of the great accomplishments of the Enlightenment; except that by the word history many meant ages. The idea of ages is itself old and derives from Hesiod's Five Ages: gold, silver, bronze,

8 James Woodburn, "An introduction to Hadza Ecology," *Man the Hunter*, ed. Richard B. Lee and Irven DeVore (Chicago: Aldine, 1968).

9 Louis Figuier, *Primitive Man* (New York NY: D. Appleton & Co., 1871), 39.

10 Eric Wolf's book *Europe and the Peoples Without History* (Berkeley: Univ. Calif. Press, 1982) was a benchmark for the development of so-called hunter-gatherer studies. Afterwards, anthropologists become increasingly aware of the political consequences of their writing. See for example: Freed R. Myers, "The Politics of Representation: Anthropological Discourse and Australian Aborigines," *American Ethnologist* 13/1 (February 1986), 138-53.

11 Richard B. Lee, Irven DeVore, and Jill Nash, *Man the Hunter* (Chicago: Aldine, 1968). See also Jack R. Harlan, *Crops and Man* (Madison, Wisconsin: American Society of Agronomy, 1975); Richard B. Lee, "Subsistence Ecology of the !Kung Bushmen," (PhD Dissertation, University of California at Berkeley, 1965); Grahame Clark, *The Stone Age Hunters* (New York: McGraw-Hill, 1967); Richard B. Lee, *The !Kung San: Men, Women, and Work in a Foraging Society* (Cambridge: Cambridge University Press, 1979).

12 Jack Rodney Harlan, *The Living Fields: Our Agricultural Heritage* (Cambridge: Cambridge University Press, 1995), 26. See also: Ronald M. Berndt and Catherine H. Berndt, *Man, Land & Myth in North Australia: The Gunwinggu People* (East Lansing: Michigan State University Press, 1970).

heroic, and iron. But Hesiod, a Greek poet who lived in the 8th century BCE, did not mean by these terms an archaeological description of history, but a cultural one that went downhill after the great Golden Age. Even when the poet Lord Byron wrote *The Age of Bronze* (1823), he meant it as a cultural descriptor where bronze was a euphemism for the present, *not*-golden age. Christian Jürgensen Thomsen (1788-1865), head of antiquarian collections of the National Museum of Denmark in Copenhagen, is credited with defining the Stone-, Bronze-, and Iron Ages in the modern sense.[13]

The system emphasized progress, from stone to bronze to iron. The superiority of one age over the next was expressed in the writings of John Lubbock, a politician, banker and amateur archaeologist who helped bring the work of Thomsen into English awareness.[14] Influenced by Charles Darwin's theory of evolution, he argued that as a result of natural selection, human groups had become different from each other not only culturally, but also in their biological capacities to utilize culture.[15] In other words, humans evolve socially much like animals evolve biologically, with Europeans as the implied end-product of this intensive cultural and biological process. It was a rather typical Victorian-era argument that implied the supremacy of the fittest ends with the white man, and, for Lubbock, with the English Empire. "The study of savages," he argues was of particular importance to the English since the English have "colonies in every part of the world and fellow-citizens in many stages of civilization."[16] In one of Lubbock's books, *The Origin Of Civilisation And The Primitive Condition Of Man; Mental and Social Condition of Savages*, he argued that the "inactivity of the savage intellect," belonging to "the lower races of men," was redeemed only with the awakening of "moral feeling," followed by the creation of mathematics, and finally the rise of law. "The whole history of man shows how the stronger and progressive increase in

13 William H. Stiebing, *Uncovering the Past: a History of Archaeology* (Oxford: Oxford University Press, 1993), 46.

14 John Lubbock, *Prehistoric Times, as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages* (London: Williams and Norgate, 1913), 3. See also Sven Lilsson and John Lubbock (ed.), *The Primitive Inhabitants of Scandinavia* (London: Longmans, Green and Co., 1868), p. v. For discussion see: Mark Patton, *Science, Politics and Business in the Work of Sir John Lubbock: a Man of Universal Mind* (Aldershot: Ashgate, 2007).

15 Bruce G. Trigger, *A History of Archaeological Thought* (Cambridge: Cambridge University Press, 1989), 173.

16 John Lubbock, *The Origin Of Civilisation And The Primitive Condition Of Man: Mental and Social Condition of Savages* (London: Longmans, Green and Co., 1902), 5.

numbers and drive out the weaker and lower races."[17] He was clearly trying to square the "scientific" definition of Europeans as "fair, sanguine and brawny" with historical reality.

Today, the use of the term Stone Age is now being debated by anthropologists and the use of the term 'savages' is a thing of the past, but the fact remains that the 'ages' have not been replaced, merely redesigned or camouflaged to appear more innocuous. Ages are now divided into ever smaller bits, usually, and obsessively, into threes: we have Early-, Middle- and Late Paleolithic; Incipient-, Initial- and Late Jōmon; Early-, Middle- and Late Woodland; Early-, Middle-, and Late Iron Age; Early-, Middle-, and Late Bronze Age, with Middle Bronze Age further subdivided into Middle Bronze Age IIA, IIB, and IIc and so on - relating to ever more specific geographical and temporal entities. In almost all cases, "late" is equated with "decline" having to do with things like population growth, ecological changes, or internal cultural weaknesses.

To navigate our ancient history these days is to navigate an alienating set of archaeological terms that drift ever closer into the realm of nonsense. One culture may be in the "Middle Iron Age" and another culture more than a few hundred miles away be in the "Early Iron Age," and down the road there may be people living in the "Late Stone Age." While this might do justice to localist narratives, the obvious fact, for example, that the pit houses of "Middle Jomon" are similar to those of the Yu'pik in Alaska and even to the Navajo in New Mexico, make it difficult for scholars to theorize cross-regional and cross-temporal tendencies. As far as I can see there is not a *single* archaeological study of this most basic and obvious circumstance, and the few studies that do exist are not by archaeologists.

The problem of abstraction also haunts the concept of pre-history, the brainchild of Daniel Wilson, a British-born, Canadian archaeologist and ethnologist. He was a scholar of Scottish history and as such was confronted with the standard image of Scotts as 'barbarians.' To counteract this, he devised the distinction in the 1850s between the 'historical' age and the 'pre-historical' age. One age had writing, the other did not, his point being that just because the Scotts did not have writing this did not mean that they lacked other skills, much less

17 Ibid., 3.

a culture.[18] In shifting from anthropology, which at that time was primarily concerned with race, to ethnography, which addressed the question of culture and context, Wilson certainly moved in the right direction. And yet, as important as Wilson's attempt at parity between 'the historical' and the 'pre-historical' was, the difference had the negative effect of reinforcing rather than challenging the class distinction between the civilized and non-civilized. It placed the entire burden of civilization on writing and not on other innovations, such as weaving, animal tending, and boat building for example. And yet, today "prehistory" remains a relatively established, though sometimes contested, category of historical understanding, though in the Americas we see now the introduction of alternative concepts like 'pre-ceramic' and 'pre-cotton.'

If the nineteenth-century fascination with ages needs to challenged – and its terminologies, in fact, abandoned - so too the late nineteenth and early twentieth century concept of the 'primitive.' Of the words discussed so far, this one is not used with any great frequency today. But that does not mean that its traces have disappeared especially since it was initially taken up among those who saw themselves as more progressive than those who liked to talk of savages and pagans. Edward Burnett Tylor, in *Primitive Culture* (1871), paved the way. Nonetheless, history is the story of how we developed from "the savage fetish worshiper" to the "civilized Christian," evolving from "lower tribes" to "higher nations."[19] Despite this, or perhaps even because of it, the book was praised at the time as laying the "permanent foundations for the science of anthropology."[20]

The difficulty of extracting anthropology from its civilization-centrism is equally apparent in the research of the German anthropologist Johannes Nikel (1863-1924). His work,

18 See for example, Daniel Wilson, *The Archaeology and Prehistoric Annals of Scotland* (Edinburgh: Sutherland & Knox, 1851), xiv. Also, *Prehistoric man: researches into the origin of civilisation in the Old and the New World* (Cambridge, Eng., and Edinburgh, 1862).

19 Edward Burnett Tylor, *Primitive Culture: Researches into the Development of Mythology* (New York: Harper & Row, 1958 (Originally Published: London: J. Murray, 1871), 501-2, 1 See also: Herbert S. Lewis, "The Misrepresentation of Anthropology and its Consequences," *American Anthropologist* 100 (1998), 716-731.

20 Taylor, *Primitive Culture*, Preface. The supposed primitiveness of primitive people was so widely accepted that in 1879 when paintings were found in the cave of Altamira, they were rejected as fraudulent and received no mention at the International Congress of Prehistoric Archeology and Anthropology held at Lisbon in 1880. Alexander Marshack, *The Roots of Civilization: The Cognitive Beginnings of Man's First Art, Symbol and Notation* (New York: McGraw Hill, 1972), 66.

as typical for German scholars of the time, was built to a large extent around the ostensible difference between *Naturvölker* and *Kulturvölker*, or people who live in nature and those who live in cities. *Kulturvölker,* though it included the Chinese, privileged mainly the Europeans and their urban ancestors. For Nikel, the difference hinges on the need for "*Arbeit*" or hard work. He begins one of his chapters thus:

> *The first flowering of culture, the dawn of the material culture, begins with work (Arbeit). The words: "You shall eat your bread in the sweat of your brow" found its most evident application where nature did not offer its bounty in abundance.*[21]

Naturvölker languishing in the context of nature's bounty did not do any "work" and thus, from Nikel's perspective, had no history. History belonged to those who *did* engage the principle of work and who, as a result, became increasingly technologically proficient. History thus moved, according to him, to those who did increasingly *more* work, that is from China, India and the Greeks to the Europeans, leading inevitably to colonialism and its re-encounter with "*Naturvolker.*" This 'contact,' so Nikel concludes, means that the West has a moral obligation to the *Naturvolker* and so he ends the book by pointing to a Christian-Social idealism that is based on the principle of happy co-existence. Religion comes in through the back door even though he argued at the beginning of the book that history has to be taken out of the hands of the defenders of religion.

The person who finally took modern religion out of the concept of the primitive was Franz Boas (1858-1942). It was not just urban people who worked, so he argued, but all people, and the deeper we get into anthropology the more remarkable the nature of that work is.[22] Differences between cultures came from historical accidents and local conditions. Boas thus emphasized the things that a society made - whether it be boats, weapons, baskets or living quarters – and that corresponded to a particular situation. He pointed to the Eskimo kayak, for example, as a sophisticated piece of equipment, even though the means by which it was made were 'primitive.' There is no such thing as a 'primitive mind,' he

21 Johannes Nikel, *Allgemeine Kulturgeschichte: im Grundriss Dargestellt* (Pderborn: Ferdinand Schöningh, 1907), p. 35. See also: Alfred Vierkandt, *Naturvölker und Kulturvölker: ein Beitrag zur Socialpsychologie* (Leipzig: Duncker & Humblot, 1896)

22 Tony Bennett, *Pasts Beyond Memory: Evolution, Museums, Colonialism* (London: Routledge, 2004), 132.

concludes, only primitive technologies.[23]

The consequences of Boas' thought, especially in the US, are clear.

Omaha Indians no longer built huts but were making "dwellings" filled with "furniture and implements."[24] Caves were now called "cliff castles," and the use of adobe as a building material was studied.[25] And there was more than just ruins that were at stake here. In the early decades of the 20th century, Indian-ness was fully embraced by the Boy Scouts, for example, as a necessary 'transition' into adulthood. And it was not just a culture of industriousness that was valued, but ritual-based, clan bonding. The Boys Scouts aimed to challenge what many pundits thought was the feminization of American boyhood. Beginning already in the 1920s, scouts were taught Indian lore to help them better "play Indian." In a few cases, Native American tribes colluded with this educational mission. The New York Governor, Al Smith received a ceremonial headdress from a Dokata chief at the 1926 Boys Scout demonstration camp at Bear Mountain.[26]

Boas' argument about the worthiness of "primitive people" fits in well with the progressive engineering mentality of the age, which explains why Boas' paper *The Mind of the Primitive Man* was first given as a lecture at the Lowell Institute of Boston Massachusetts in 1910. The Institute was founded by the son of a noted industrialist Francis Cabot Lowell (1775–1817). Allied with the Massachusetts Institute of Technology, it had a Teachers School of Science and hosted lectures, like the one Boas gave, to members of the Boston public. 'Primitive' appealed in particular to the differences between the industrialized countries and the non-industrialized ones and was thus also obviously entangled in the rise of the modern nation-state. Boas may have wanted to elevate "the primitive mind" from the absurdities of racial arguments, but the word was nonetheless, a code-word for cultures which, though industrious, lived outside the technological and scientific jump that metal entailed. He expresses the opinion that the anxiety about "negro problem" in the United States

23 Franz Boas, *Primitive Art* (New York, Dover Publications, 1955), 2.

24 James Owen Dorsey, *Omaha Dwellings, furniture and implements* (Washington D.C.: Smithsonian Institution, 1896).

25 Neil Merton Judd, *The use of adobe in prehistoric dwellings of the Southwest* (Washington: United States National Museum, 1916); *Cliff castles and cave dwellings of Europe (*Philadelphia: J.B. Lippincott, 1911).

26 Jordan, Benjamin René. *"A Modest Manliness": The Boy Scouts of America and the Making of Modern Masculinity, 1910-1930* (University of California San Diego: 2009), 222, 223. Retrieved from: http://www.escholarship.org/uc/item/6s56c7cg

is largely unwarranted since Africans are a "healthy primitive people," who exhibit "a love of labor and interest in the results of work."[27]

By the 1950s, 'primitive' had expanded into a vast, unself-reflective, interdisciplinary project headlined by the reprinting of Boas' books *Primitive Art* (1925, 1955) and *The Mind of the Primitive Man* (1911, 1963).[28] Scholars by the dozens wrote books and articles with the word primitive in it, preserving the image of an ancient life that - even if it was industrious - was still crude, static, or childlike.[29] The first show on "Primitive Art" was held in 1940 at the University of Minnesota. The now defunct Museum of Primitive Art in New York was founded in 1957 and soon books appeared like *Primitive Art of the Pacific Islands* (1957), *Paul Klee and Primitive Art* (1962) *Primitive art: its traditions and styles* (1962) and, perhaps worst of all, *Primitive Architecture* (1975).[30] One art historian, none other than the formidable Anthony F. Janson claimed even in the mid 1980s that even though "primitive is a somewhat unfortunate word, ... no other single term will serve us better. Let us continue then, to use primitive as a convenient label for a way of life that has passed through the Neolithic Revolution but shows no sign of evolving into the direction of "historic" civilization."[31]

Today, few scholars would dare use the word 'primitive,' but that does not mean that its imaginary has been purged from our scholarly perspectives. In architecture it was

27 Franz Boas, *The Mind of Primitive Man* (New York: E. Macmillian, 1911), 271, 270.

28 George Murdock, *Our Primitive Contemporaries* (New York, The Macmillan Company, 1934); Paul S. Wingert, *Primitive Art: its Traditions and Styles* (New York: New American Library, 1962); Anthony Forge, Ed., *Primitive Art and Society* (London, Oxford University Press, 1973); Enrico Guidoni and Robert Erich Wolf (trans.), *Primitive Architecture* (New York: H. N. Abrams, 1975); H. Gene Blocker, *The Aesthetics of Primitive Art* (Lanham, Maryland: University Press of America) 1994.

29 Some scholars have recently even tried to redeem the word by pointing to its Latin root, primus which means first or oldest, but the word's long entanglement with 19th century evolutionary ethnography makes such attempts unwise Even if used in a "positive sense" a scholar can claim that "all primitive peoples are marginal to the mainstream of modern history, primarily because of such 'accidents' of habitat as removal from the developing centers of civilization." Stanley Diamond, *In Search of the Primitive: a Critique of Civilization* (New Brunswick: New Jersey: Transaction Publishers, 1974), 130-131. Okot p'Bitek (1931 – July 20, 1982) who was trained at Oxford as an anthropologist specializing in African oral literature critiques the attempt to sanitize the word. See: Jahan Ramazani. *The Hybrid Muse: Postcolonial Poetry in English* (Chicago: University of Chicago Press, 2001), 155.

30 The idea of "primitive architecture" was first produced by Barr Ferree (1862–1924), who point out that man moved from caves to wind shelters to huts.

31 Horst W. Janson, *History of Art,* (New York: Abrams, 1986), 35.

replaced by the word 'vernacular, ' which appeared quite suddenly in the 1970s just as primitive began to be discredited. In the early nineteenth century the term was used by scholars to describe European languages that were not Greek and Latin. This coincided with an emerging Romantic-era fascination with the cultures, languages and even fauna of local regions. The word was never used in an architectural sense, which makes its expansion into that field all the more remarkable – and unfortunate - since the word derives from the Latin word *vernaculum*, a shack where slaves lived at the back of a garden in a Roman villa, which in turn comes from *verna*, 'a slave born at home' to distinguish slaves born from slave parents in a Roman villa from a slave bought in the market. Etymology alone should lead one to reject usage of the word, but it is too late, since the three volume *The Encyclopedia for Vernacular Architecture* (1997) is a leading reference book in the field.

The root of the problem is, however, a deep one since the high/low dualism that it embraces is built on the Renaissance-era elevation of architecture into a fine art, one that requires mental abstractions, drawings and the fulfillment of representational needs. Ever since, the discipline has more or less adopted the a relatively hard distinction between "architecture" and "building" – as it as characterized in the nineteenth century - or as it is now phrased, between "architecture" and "vernacular." The Smithsonian Museum labels the Great Mosque of Djenne Mali as "vernacular" on its much-used web site, even though the building is designed according to a specific plan and is hardly shack-like.[32] We do not know who the designer was, but by that logic, many of the European cathedrals could be called vernacular. Certainly the people in Djenne do not see their building as a 'vernacular,' but as an example of 'high' architecture.

"Vernacular" removes both agency and history from the equation. Bernard Rodofsky, for example, coined the phrase "architecture without architects" in the title of his exhibition at the Museum of Modern Art in 1964.[33] This was not based on any anthropological study what so ever. The exhibition was almost wholly based on photos taken from magazines and newspapers. Though it challenged the normative Eurocentrism of time, its purpose was to contrast the ostensible 'humanness' of primitive architecture against a culture of

32 http://sirismm.si.edu/siris/top_images/eepa.top.08_2007.htm

33 Bernard Rudofksy, *Architecture Without Architects: a Short Introduction to Non-Pedigreed Architecture* (New York NY: Museum of Modern Art, 1965).

modernist alienation. Though today's architectural theorists will have nothing to do with Rudofsky, his name and work still resonate in the architectural design community.

Post-First Society People (I.E. You And Me)

Homo sapiens, hunter-gatherers, foragers, pre-history, stone age, primitive, and vernacular are commonly-found words in discussions of our early history. They and their associated proxies and avatars are toxic and need to be removed from our discourse. Clearly, post-structuralists have begun the process. Some talk of a polyphony of voices, others challenge the use of meta-narratives, and yet others remind us that cultural meanings are inherently slippery, and that they are negotiated by makers and users, and even by interpreters such as the anthropologists and historians themselves.[34] It is, however, obvious that such critiques have had only a limited impact. The concepts I discussed remain in one way or another firmly entrenched as disciplinary institutions.

I am concerned less with the paradoxes of ethnographic knowing than with the *trans*-disciplinary historiographic pattern created by our civilizational presumptions, for it demonstrates that we are still trapped in a desire to articulate the difference between our world and that which always seems to haunt it as a predecessor condition.[35] In the post-Enlightenment sense, being human pointed inevitably to something like a 'pre-human' non-*sapien*s, or to a 'just-before-human' or, if we think of the word vernacular, to a 'just-before-the-modern.' And in those terms, we were also quick to draw a hard line between our time and an earlier time.

Robert Keesing writes that radical alterity, as "a culturally constructed Other radically different from us fills a need in European social thought." We tend to "overstate Difference," he says in search for the "exotic" and the "other" as part of a

34 I am thinking here of the writings by James Clifford and Ian Hodder. James Clifford *The Predicament of Culture: Twentieth-Century Ethnography, Literature, and Art* (Harvard University Press, 1988). Ian Hodder, *Reading the Past. Current approaches to interpretation in archaeology* (Cambridge: Cambridge University Press, 1986). Jacquetta Hawkes's 1968 essay in *Antiquity*, "The Proper Study of Mankind," was something of a touchstone in the science wars in archaeology. She was strongly critical of scientism and the faith in the universal application of scientific procedures and technical reason.

35 If we adopt a nominalist position and reject all the various abstractions that we have used to define this predecessor condition we might wind up 'losing' the gains, such as they are, that the disciplines insistently claim that they have provided. But to accept these abstractions is to more or less admit to the rather low, common denominator of intellectual pragmatism.

"Western cravings for alternatives.[36] I think Keesing overstates and understates the problem, for the question is bigger than even "European social thought" as it harkens to the philosophical foundations of the civilizational 'break' that occurred in several places in the world beginning around 6,000 BCE or so. It was not a European or Western phenomenon, but rooted in more ancient polarities of city people versus villagers, forest people, nomads. It was just as true for the Chinese as for the Romans. Even the ancient Sumerians, in the 3rd millennium BCE poked fun at forest people. Did not Eridu, once he himself became civilized, purposefully cut down the sacred forest, drive out their inhabitants and reduce the logs to timber for the city gate? It is a process that continues to this day in Brazil, Africa and in India, where forest people are officially labeled as "the Backward Classes."

One way to begin to solve the problem of theorizing our predecessor condition is to invert the lens. Suppose, for example, that we live in a condition that is post- or after-. That might at least correct the tendency to write history *towards* us, rather than to write history *away* from 'the earlier.' If we do not see "hunter-gatherers" as an alien social formation, but ourselves as the *later* formation of them, does that not change the security of our perceptions. In this respect, let me state an obvious fact. The age of "hunter-gatherers" is not over yet! They are still around, though nominally. Sadly, the "age of the hunter-gatherer" which began around a million BCE will probably end in the next decade (!), which puts a lot of pressure on us to awaken to this terrible fact. Is their ancestral history not in some ways (still) our history? Or are they just a set of people living in remote deserts and forests, subject to the terrors of mining companies even as they build with bamboo, use plastic plates and drink Coca Cola? What would a history from the !Kung perspective sound like? And, just as importantly, can we respect that history without anthropologists reducing it to "hunter-gatherer ethnography?" The point – to be clear - is not that a !Kung writer would produce an authentic or 'native' history free from the trappings of her encounter with "others" (namely us). On the contrary, to produce a history of the world outside them, the author would be in many ways modern, but it would be a different type of story than the ones we are familiar with. The absence of such voices except occasionally

36 Robert M. Keesing, "Theories of Culture Revisited," *Assessing Cultural Anthropology*, Edited by Robert Borofsky (New York: McGraw-Hill, 1994), 301-310.

in the field of literature means that we will always be on one side of the equation and never on the other.

A possible starting point would be to see people not as magically *sapien*, not as "hunter-gatherers," not as "primitives," or "prehistoric," or as builders of some timeless "vernacular," but quite simply as First Societies, of which there might be any number of variants. If that were the case, then we are post-First Society people – perhaps something like a Second- if not Third Society people. Can we write the history of who we are today from our post-First Society perspective? The answer from my historian colleagues will probably be no, but my response is that we are quickly coming to the end of what our various disciplines - be they anthropology, history or science - can say at least in the conventional sense, largely because these disciplines rely so heavily on terminological abstractions that by their very nature and connection to Enlightenment ideals privilege the principle of civilizational maturity. Perhaps there is, after all, a philosophical question around how we as humans exist(-ed) that trumps the pragmatic argument that abstractions of ourselves have to be accepted, if not as the privilege of disciplinary knowing then as practical necessities - the so-called professional standards by which we can measure our epistemological advances.

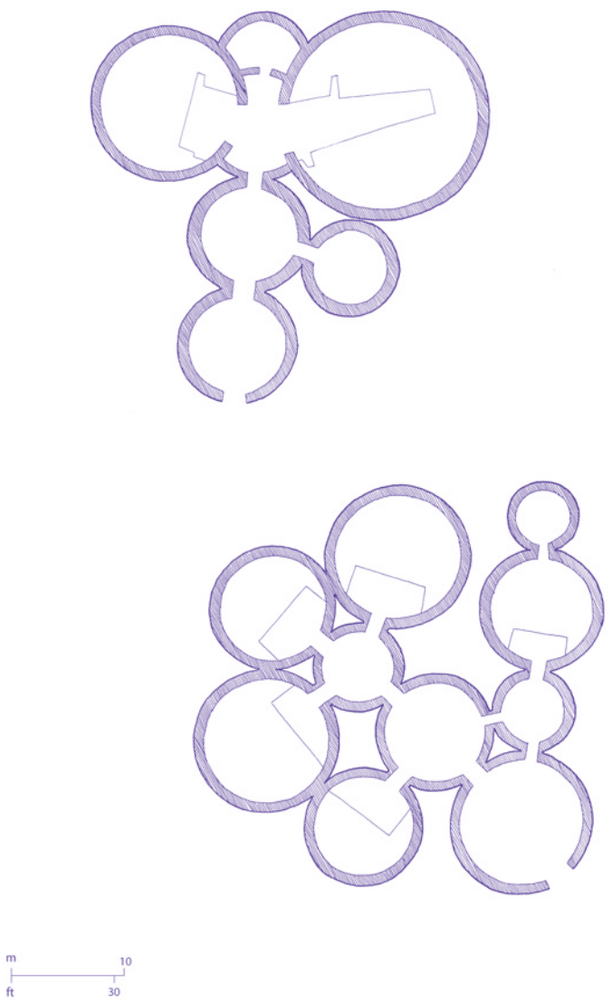
Beginnings:
Drawing Early Architecture

—

Timothy Cooke
Andrew Ferentinos

The following drawings were originally commissioned for the book "Architecture of First Societies: A Global Perspective" by Mark Jarzombek (Wiley, 2013). In total, more than 300 hand drawings were produced for the project over the course of three years. This selection is reprinted with permission from the individual artists. The accompanying text is reproduced with permission from Mark Jarzombek.

— Figure 1 —



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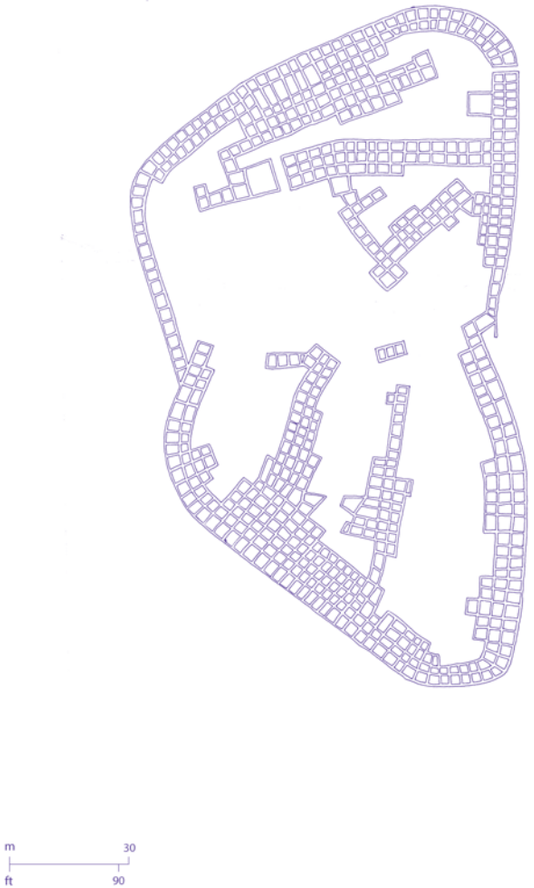

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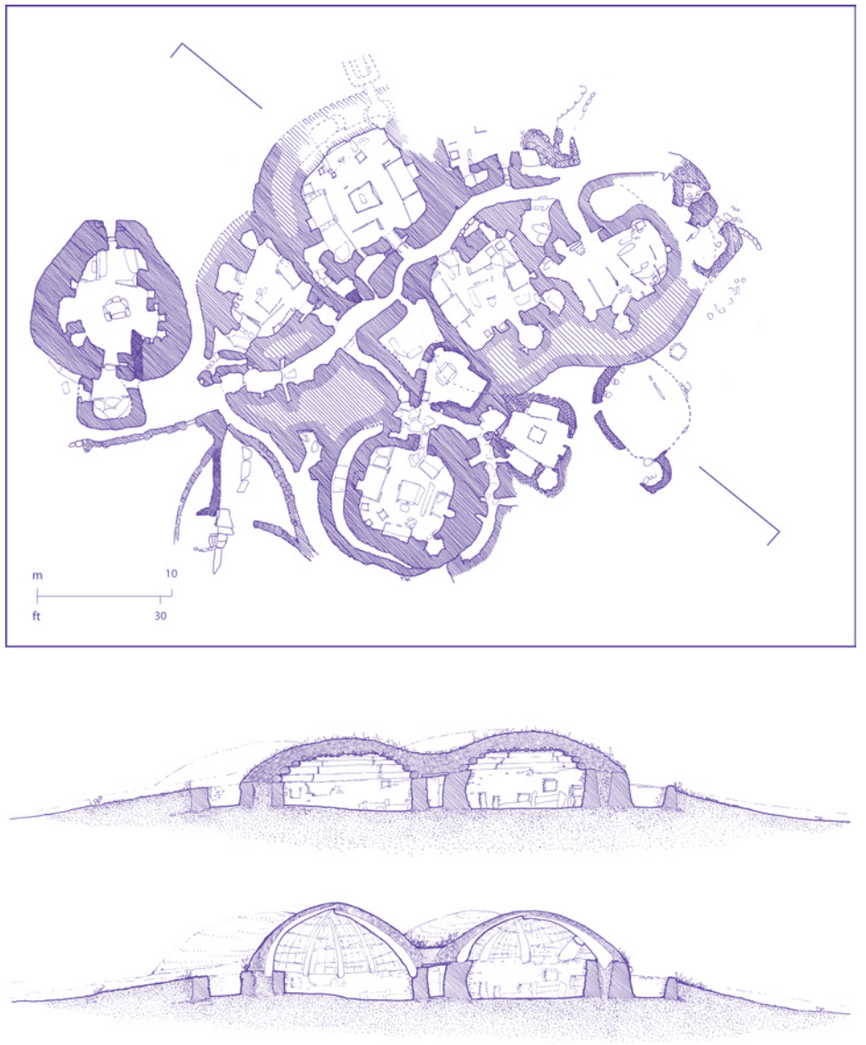

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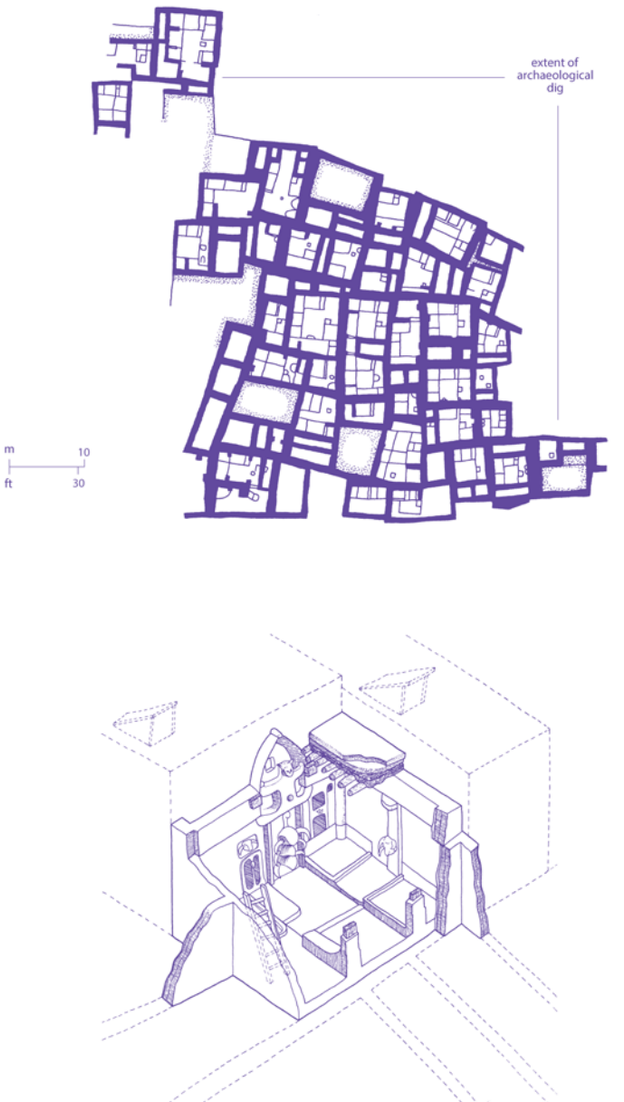

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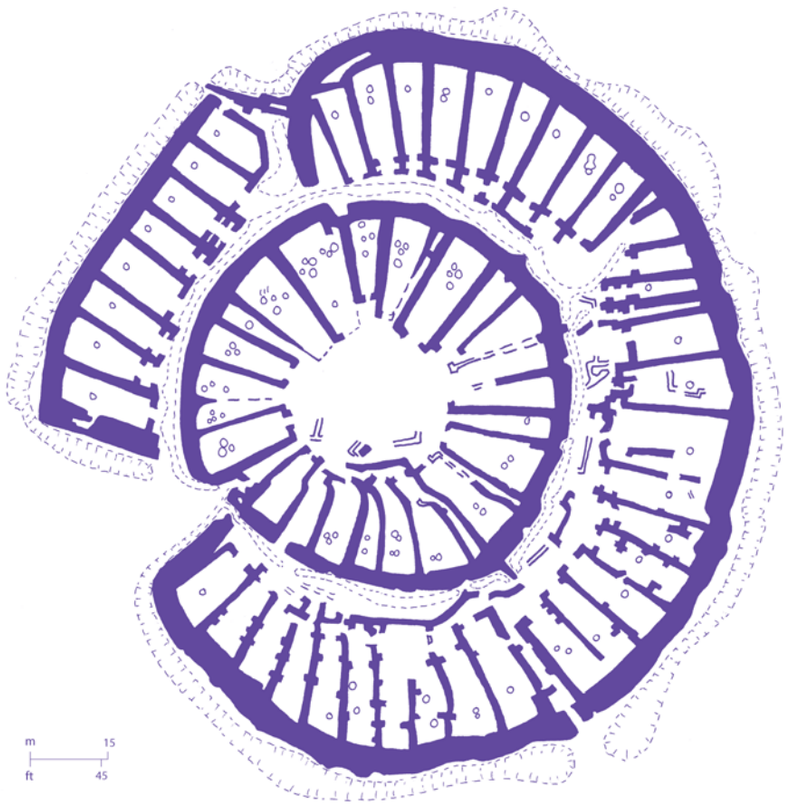

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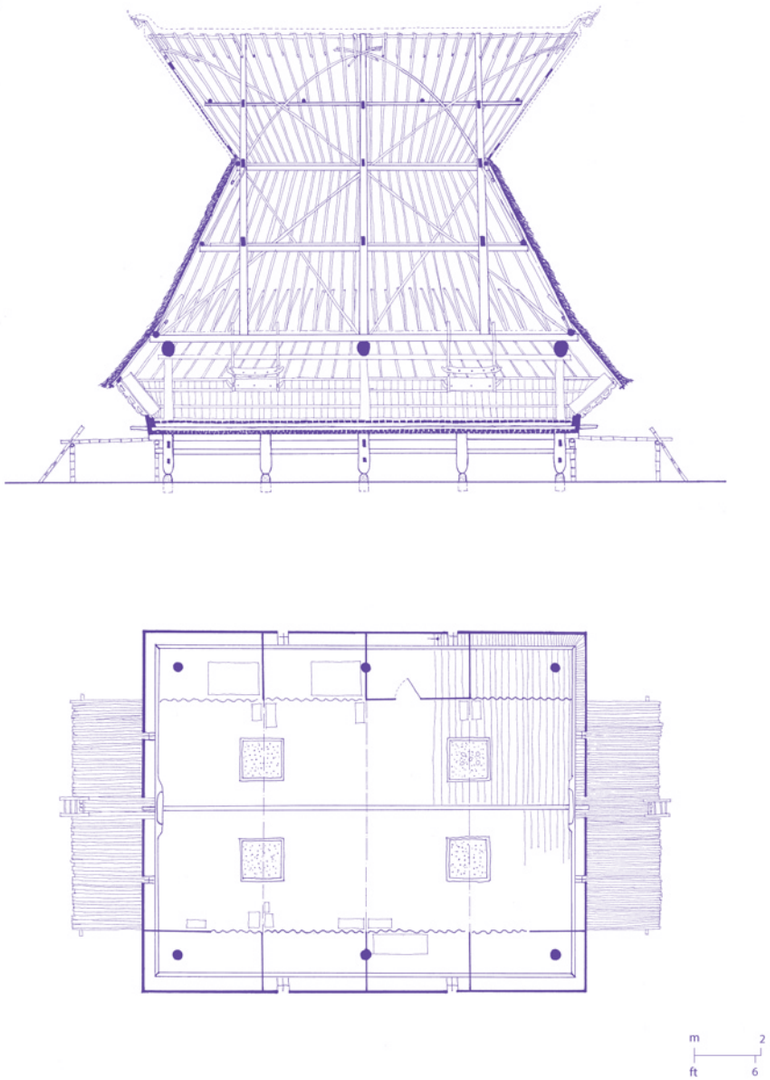

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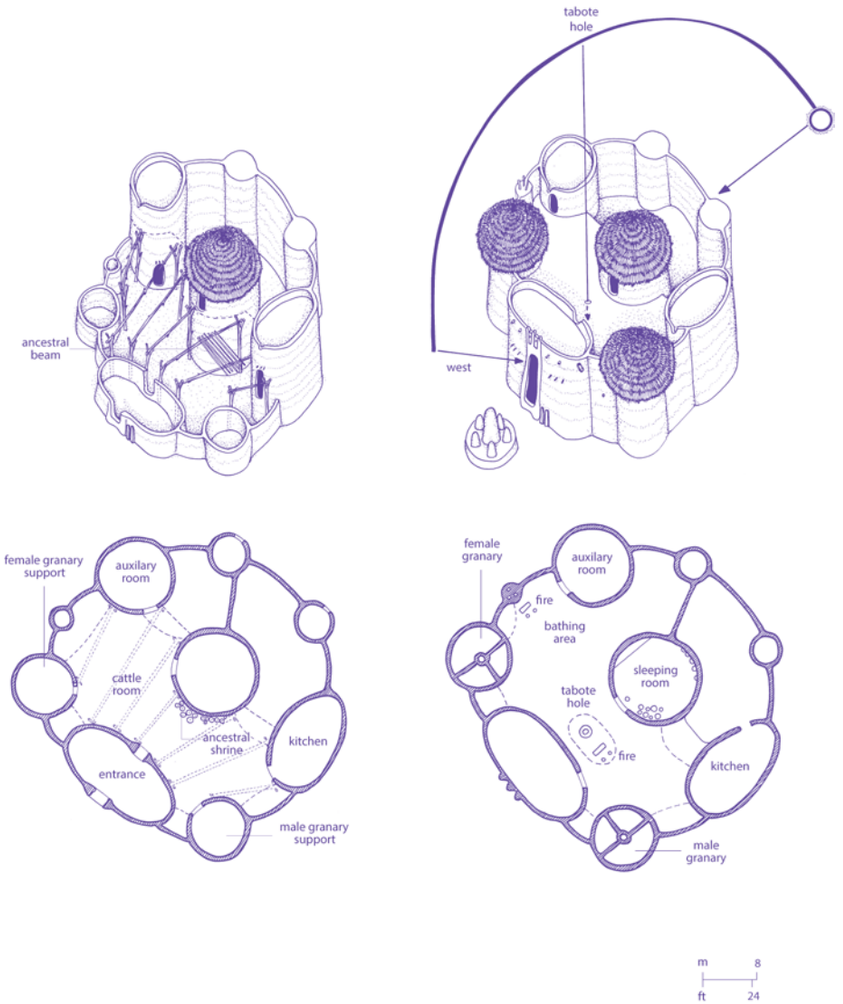

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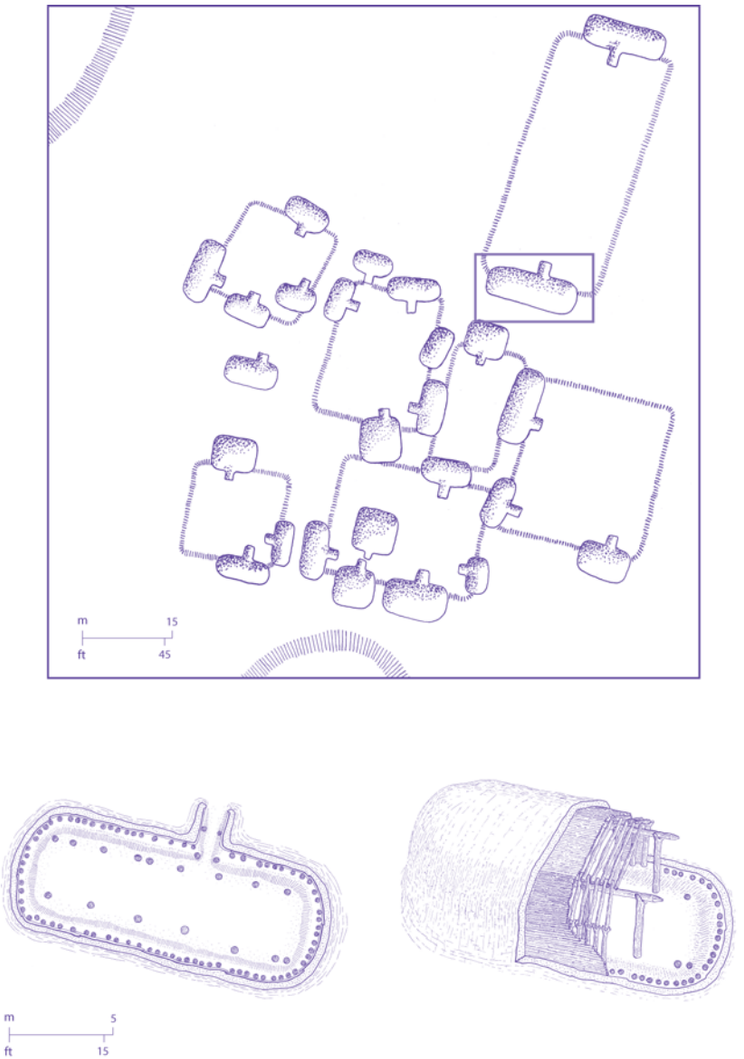


— Figure 9 —

Figure 1
— Orangia I, South Africa
Site plan

One of dozens of sites from about 100,000 to 60,000 BCE located in a canyon that was used during the dry season, when both humans and animals congregated along the shores of the river. This site was an easily guarded ledge with a cliff behind it protecting the humans from predators. If similar Australian aboriginal sites are any indication, these C-shaped rock enclosures document the arrangement of individual family units organized into mini-clans.

Drawing by Andrew Ferentinos

Figure 2
— Igloos, Alaska, USA
Plans

Igloos are the characteristic architecture of the Inuit in the Canadian north. The two shown here house multiple families and are used for ritual winter events.

Drawing by Timothy Cooke

Figure 3
— Kin Tiel, New Mexico, USA
Plan

The Zuni built this relatively compact pueblo around 1275 CE. The pueblo was two stories high at least and contained over a thousand rooms. The curvilinear plan straddles the track of a spring.

Drawing by Timothy Cooke

Figure 4
— Skara Brae, Orkney, Scotland
Plan and section

Around 3000 BCE, the weather in what is now Scotland was warmer than today, allowing affluent settlements to take root. One of these is Skara Brae, where houses were partially dug into the earth and then enclosed with thick stone walls. The stonework is exquisite and shows a high level of skill. How they were roofed is not known. One drawing shows the houses covered with logs and earth, the other shows the houses covered with a whalebone roof.

Drawing by Timothy Cooke

Figure 5
— Çatal Höyük, Turkey
Plan and cutaway axon of a dwelling unit

This settlement was no mere village, but neither was it a city; perhaps it can best be described as a very compact village. Dating as far back as 7400 BCE and lasting to about 5500 BCE, it had a population of about eight thousand at its peak. The settlement consisted of rectangular flat-roofed houses packed together into a single architectural mass with no streets or passageways. There was, in that sense, no “public” space. The outside of the settlement presented a solid blank wall made of mud bricks and reinforced by massive oak posts. There were, however, open areas that separated “neighborhoods”, perhaps work areas or places from which access to the roofs could be monitored. Inhabitants descended into their homes through openings in the roofs by means of ladders. The roof was in every sense a public area, not much different from how the Hopi used roofs in the Southwest United States.

Drawing by Nadine Volicer

Figure 6
— Sintashta culture, Arkaim, Russia
Village plan

This fortified village where metal was smelted and manufactured was protected by two circular walls with a circular arrangement of dwellings and an open, central space at its core. Built around 2100-1600 BCE, all houses had the same floor plan: an economic zone in the rear, a living zone, and a porch fronting the center of the settlement that also had stairs leading to the roof.

Drawing by Timothy Cooke

Figure 7
— Batak, Sumatra, Indonesia
Plan and section

Of the Batak tribes of Sumatra, the Karo have more than others resisted change from external influences and retained their traditions. The houses are rectangular or square and supported on strong wooden piles about 1.5 meters high. Above this are the main living quarters with wooden walls slanting outward and topped by a gently curving saddle roof. The roof is exceptionally high in comparison to the low walls. The interior of the house, even though it is divided into apartments, is quite open, producing intense social interaction and limited privacy. Residential areas consist of a kitchen, a living area, and an enclosed sleeping area. Each house has two open platforms, one to the east and the other to the west.

Drawing by SunMin May Hwang

Figure 8
— Batammaliba, Togo, Africa
First and second floor plan and cutaway axons of a house

For the Batammaliba, architecture is deeply rooted in the concept of the universe and in their understanding of what it means to be a human. The house, in fact, is treated like the anatomy of a human in that it has eyes and doors and a front and a back. Houses are also aligned to the sunset of the winter solstice. The sun enters the house through the west-facing door and symbolizes the return of Kuiye, the sun deity, who is also understood as the first architect who built the earth and constructed the first domicile for himself and his first sons. He is both male and female. Kuiye’s residence is placed in the western sky as well as the village of the dead. Each house in that village is a replica of the house in which that person lived.

Drawing by Daniele Cappelletti

Figure 9
— Snaketown, Arizona, USA
Village plan, house plan and cutaway axonometric

Snaketown was a large Hohokam settlement situated on the north terrace of the Gila River. It was founded around 600 CE and developed into an important center by 1000 CE. The houses are of the pit house type, the beams holding the roof standing on the floor of the pit, not on the surrounding ground level. The different sizes of the houses are indicative of the existence of social hierarchy.

Drawing by Andrew Ferentinos

THE PHARMAKON AND THE MACHINE
GINGER NOLAN

A young French doctor, Jean-Marc-Gaspard Itard, tried to teach the Wild Child.... But even after seven years of the most painstaking, systematic, and often inspired pedagogy, the boy never learned to speak, to read, or to write. He never told what he knew. He never told if he knew.[1]

Sherry Turkle, The Second Self:
Computers and the Human Spirit

Writing, Phaedrus, has this strange quality, and is very like painting; for the creatures of painting stand like living beings, but if one asks them a question, they preserve a solemn silence. And so it is with written words; you might think they spoke as if they had intelligence, but if you question them, wishing to know about their sayings, they always say only one and the same thing.[2]

Plato, Phaedrus

Plato's dialogue, *Phaedrus,* opens with Socrates and his pupil leaving the city under a hot midday sun and wading through a shallow stream towards the origins of things: if not to an actual springhead then at least to the vicinity of a certain wizened tree, some distance from the city, where an exchange between gods and mortals was said to have taken place long ago. This transgression beyond the city walls has been interpreted by Jacques Derrida as structurally significant to Plato's dialogue, the path marking a traversal from the locus of writing into a different modality of knowledge. Here though, I would interject another path, described in another text, and thereby produce a chiasmus between these two routes, each representing different conceptions of human-technological relations. The words with which Socrates and Phaedrus wend their way from city to wilderness could be bisected with another string of words, authored roughly two millennia later, describing a young boy walking in the opposite direction—out of the wilderness and into civilization—and yet also, like Phaedrus, leading philosophy along with him on this path. The latter path, sketched out in Sherry Turkle's *The Second Self: Computers and the Human Spirit*, begins with an account of a young boy, Victor d'Aveyron, living in France at the turn of the eighteenth century, whose long isolation in the forest and his subsequent aphasia led him to enter history as an "*enfant sauvage*" or "wild child". Turkle, who was a close associate of the MIT Media Lab's founding members, Seymour Papert and Nicholas Negroponte, argued that the philosophical questions raised by this boy's lack of language foreshadowed present-day questions around computer programming: specifically, around relationships between computers and the human mind; or, as she called it, "the human spirit".[3]

The projection of a chiasmus between texts as far-flung as Turkle's and Plato's could not be justified merely on the coincidental transection of two footpaths between wilderness and *polis*. More crucially, what draws these works towards each other are certain themes regarding how human selfhood relates to technologies of transcribing, transmitting, and negotiating knowledge. The chiasmus highlights a convergence that also becomes a divergence. For Plato, polis and wilderness pertain to distinct modes of knowledge: the former bound up with the technology of writing; the latter estranging people momentarily from writing's structures. In traversing between polis and wilderness then, the political citizen constitutes himself as a technological human (i.e., a writing and reading human) who nonetheless can question and critique those same technologies of self which, in the city, are so inseparable from his habits of thought. In the propositions of Turkle, Negroponte, and Papert, on the other hand, we see that the distance between polis and wilderness becomes more insuperable even as the polis/wilderness distinction (related for them to city/ghetto and global North/South distinctions) is obfuscated through new media-technologies. As media-technologies bridge the space between places and between one's self and one's technologies of self, they also run the risk of precluding traversal between them. Such was the fate of Victor d'Aveyron, the wild child who was removed from the wilderness.

The Wild Child

In 1797, a boy deemed to be about twelve years old, who had been abandoned as a very young child, was captured near the French village of Saint-Sernin, in a forest. He had apparently survived on his own for seven or eight years and had thus either

1 Sherry Turkle, *The Second Self : Computers and the Human Spirit* (New York: Simon and Schuster, 1984).
2 Plato and Benjamin Jowett, *The Dialogues of Plato*, 3d ed., 5 vols. (London,: H. Milford, Oxford university press, 1931).
3 Turkle, *The Second Self : Computers and the Human Spirit.*

forgotten or never learned human language. Later, in 1801, the doctor Jean-Marc-Gaspard Itard, took custody of this young aphasic in order to teach him language and social comportment, an endeavor that met with very limited success. Broadly speaking, Victor's condition spoke to the indistinct boundaries between human and animal, or, relatedly, between human and machine. Itard's work with Victor thus aimed to offer an empirical supplement to eighteenth-century speculations on the origins of human language. As would be suggested later by Turkle, Itard's work foreshadowed twentieth-century inquiries into machine intelligence and language by asking how a "blank" mind—an aphasic mind that had already outgrown the infant's magical capacity to acquire language—might nevertheless have the mechanisms of language-acquisition implanted within it and, subsequently, all the social assimilation that language alone could enable. Opening her book with the story of Victor, Turkle describes the education of the Wild Child as a "forbidden experiment" come to life and notes that today "there is a new focus for a forbidden experiment. A new mind that is not yet a mind. A new object betwixt and between.... This is the computer."[4]

It should be noted, however, that Turkle's retelling of Victor's story is slightly misleading in a few instances. She begins *The Second Self:*

> *On a cold January dawn in 1800, a boy of about thirteen came out of the woods... He walked out of the woods to enter history and, what is perhaps more to the point, to enter modern mythology as someone with a secret to tell. As a human being who had lapsed back to the animal condition, he was thought to embody the "natural." His way of thinking, if he could be taught to communicate, would testify to the condition of "man in nature.*

Yet Victor's reunion with society did not actually begin with an easy stroll out of the dark forest into civilizing sunlight on a January day—i.e., *at the originary dawn*—of the mythically-charged centennial year of 1800. Rather, he first re-encountered society a few years earlier when a search party unleashed a pack of hunting dogs on him. Victor escaped after a week of abusive captivity but then in 1800 once again found himself fleeing the forest in terror from hunters and seeking refuge in a nearby cottage.[5] The late-Enlightenment "self" that Turkle's version does not account for must be understood with reference to

4 Ibid.

5 See: Michael Newton, *Savage Girls and Wild Boys : A History of Feral Children*, 1st U.S. ed. (New York: Thomas Dunne Books/St. Martin's Press, 2003).

the repeated violence with which dogs were unleashed upon a frightened child. Metonymic of the Republic's own recent Terror, Victor's terror in fleeing his hunters revealed the contradiction embodied in his person. Resembling that originary noble savage whom pre-Revolutionary philosophers had hypothesized, Victor personified the natural human habits idealized by the Revolution while also representing the kind of savage uneducability that—to the extent that all humans bore within them this potential liberty and resistance to assimilation—tested the limits of the Republic's governance. Victor's savagery thus presented an opportunity to test the boundaries and potentials of governance, to determine how to civilize the uncivil, to reprogram even the most savage of human minds. However, as Turkle's allusions suggest, Victor's mind could be seen as key not only to the programmability of humans but also of intelligent machines. According to Papert, a founding member of the Media Lab who invented the programming language, LOGO, childhood interaction with machines would reveal how both humans and machines might acquire intelligence through each other.

The Origin Turned Supplement

In *Phaedrus,* Socrates discusses with his young pupil the nature of truth and selfhood in relation to the technology of writing. Reclining on the banks of the Ilissos, mingling their voices with the simple chirping of the cicadas, Socrates tells Phaedrus how writing was invented by the Egyptian god, Theuth, to substitute for vocal speech. Derrida, in his reading of this dialogue, thus offers a theory of "the supplement": a substitution for an original that simultaneously augments and falls short of the origin that it differently analogizes.[6] Given Plato's recurring comparisons between forms of writing and medicine, Derrida notes that the "pharmakon"—which can refer equally to philters and poisons—could be a metaphor for the supplement of writing, with its similarly ambivalent powers of drawing people closer to, yet also further from, the truth of things. Writing, Derrida says, forms a supplement to speech in a relationship akin to that between son and father. In the absence of the father (the origin of self), the patriarch's living speech is substituted or supplemented by writing, an art that, having sprung apart from its vocal origin, attests to a certain instability—a backward and forward movement between origin and supplement—stirring restlessly at the heart of representation and knowledge. *Phaedrus* thus gestures

6 Jacques Derrida, *Dissemination* (Chicago: University Press, 1981).

towards the liminal conditions of human-ness: liminal because of the self's amnesia regarding its own originary source and, hence, the impossibility of inborn truth, which leads to all the prosthetic modes of representation and anamnesis. Socrates and Phaedrus travel out of the city (the locus of writing and, incidentally, where Socrates, though he is not given to writing, claims to feel most at home) in order to better converse about writing. We might consider the "self" then not as *grounded* within a field of social or technological relations so much as interpolated by wandering trajectories between the poles of the originary and the supplementary. The absence of any origin as such does not preclude this traversal, provided that the journey be understood less as a search for origins than as a search for a vantage point from which to grasp the workings of the supplement. One does not travel from "the city" (the city *qua* supplement) in search of some originary Nature, but rather so as to render the city itself—and its associated technologies of writing—more intelligible; so as to see how inhabiting the city should entail a process of translation between city and non-city. This is not simply to understand the human as always-already bound in technologies of thought, but to stress the importance of knowing what those technologies do.

These traversals between origin and supplement should be differentiated, however, from a tendency Victor renders evident, namely an obfuscation between origin and supplement, due to the origin's association in modernity with what is savage and infantile. Whereas for Plato the origin was the patriarchal well-spring of truth, law, speech, and authority, in eighteenth- and nineteenth-century France the origin referred to a different, silent kind of truth: the truth of nature's mechanistic laws (distinct from the conventional laws of society) whose mute secrets, if made to speak, would supposedly enable an understanding of the workings of the human mind. In turn, such knowledge would enable the Republic to merge its power with the basic mechanics of the human mind, rather than working through physical coercion.

Yet with the event of Victor's capture, we witness the "original" in all its phantasmagoric instability. The human origin that Victor embodies doubles as its own supplement: a supplement or substitution for extant theories of savage or natural thought, such as Condillac's and Rousseau's postulations of how an originary "wild child" might have magically developed human language from non-language.[7] Philosophers' speculations on the primitive origins of language both preceded and necessitated the advent of a pre-linguistic "wild child", thereby rendering the actual origin a mere supplement to theory, an empirical exponent to theories of human intelligence.[8] The actual savage, Victor, was the key to proving and advancing existing theories on the mechanisms of language acquisition. In *Discourse on the Origins of Inequality*, Rousseau, echoing a similar claim made by Condillac, argued that spoken language must have been invented by infants because, in their helplessness, they had the greatest need to communicate. Rousseau's attribution of the origins of language to a condition of infantile dependency (in contrast to Plato's ascription of speech to the parental figure of guidance) sets up language as a form of supplication rather than of contestation. Whereas Socrates' venture into the wilderness led him to brush against the divine origins of truth, the late Enlightenment's analogous figuration of originary truth took the form of a slovenly, needy, and terrorized child who possessed neither rights nor philosophical wisdom. Thus infantilized and degraded, truth seemed to abdicate its associations with authority.

From Plato to PLATO (Programmed Logics for Automated Teaching Operations)

Derrida notes that in *Phaedrus* the relationship between the city and its surrounding wilderness is closely analogous to the relationship between written texts and the direct, spoken transmission of knowledge. That is to say, there is a kinship between the mediated "nature" of the city and mediated modes of thinking; between habitation and mental habit. A somewhat different coupling of architecture and epistemology lay at the roots of the MIT Media Lab, which sprung jointly from Negroponte's Architecture Machine Group and Papert's research on educational interactions between artificial and human intelligence. What drew these projects together was their directors' shared interest in displacing the authority invested within a particular human, be it an architect or a teacher. For Negroponte, the Architecture Machine displaced the problematic figure of the Northern

7 Jean-Jacques Rousseau et al., *Discourse on the Origins of Inequality (Second Discourse) ; Polemics ; and, Political Economy*, The Collected Writings of Rousseau (Hanover, NH: Published for Dartmouth College by University Press of New England, 1992).

8 Derrida suggest something similar to this confusion between origin and supplement in his critique of Condillac's proposed science of language. See: Jacques Derrida and Etienne Bonnot de Condillac, *The Archeology of the Frivolous : Reading Condillac* (Lincoln: University of Nebraska Press, 1987).

architect-planner in the Global South. Rather than having a cadre of American experts impose its urban schemes on foreign subjects, the Architecture Machine would provide a technology for supposedly consensual, locally-inflected design solutions. The Architecture Machine would work as a kind of "democracy" machine, exporting from the U.S. an anti-communist system for urban management, in lieu of delivering a completely designed urban entity.

Papert's proposal for a research center on human-computer pedagogy was enfolded within a larger MIT initiative to address the changing needs of secondary schools in the wake of the United States' recently instituted racial integration policies across school districts.[9] Hailing from South Africa where he had been active in the anti-apartheid movement, Papert maintained that education should be treated as a means of empowerment available to all people, regardless of class or race. In a 1977 grant proposal for studying the applications of personal computing in the classroom, he argued that computers should not simply mimic the pedagogical methods that already prevailed, especially those tending towards rote acquisition of information and skills; rather, young pupils should learn to program computers, play with them, and thereby develop creative problem-solving skills.[10] He argued that computer education could, ideally, enable "learning to learn without dependence on being taught".[11] He drafted this proposal for a humanistic computer-pedagogical research center a year after the 1976 uprisings in Soweto in which thousands of schoolchildren rallied against the apartheid education system. His proposal was likewise written a year after various uprisings in U.S. cities, including Boston, *against* recent desegregation measures which mandated busing between school districts. It was in response to such educational reforms that MIT proposed the spread of new technical training programs in primary and secondary schools, leading to an eventual collaboration in the 1980's between the Media Lab and an impoverished public elementary school in Boston.[12] The assumption for both Negroponte and Papert was that the transferal of authority from the human expert or human teacher to the machine would obliterate authority altogether. This attitude

9 MIT, "Secondary Technical Education Study / Plan for Mit-East Boston Technological High School (1977)," (MIT Institute Archives).
10 Seymour Papert, "Computers and People: A Concept of a Center of Excellence in the Study, Development, and Applications of Personal Computer Power (1977 Draft)," (MIT Institute Archives, AC 117).
11 Ibid.
12 See: Catherine Slater Spence, "Computers Don't Teach, Students Learn in Hennigan School Project" *The Christian Science Monitor,* August 24, 1986.

stands in contrast to Socrates' admonition to Phaedrus: that the problem with written words is that, unlike humans, their authority, literally, cannot be questioned.

Papert's recognition of the computer's essential ambivalence undergirded his criticism of how classroom computers were being used merely as rote quizzing devices, leading him to echo Turkle's call for a new field of "Humanistic Computer Studies".[13] He described the potential dangers of personal computing in terms similar to Derrida's formulation of the pharmakon: "The computer," Papert wrote, "is a potent instrument for mental change, and just as drugs which cure can also kill; so too, presumably, immersion in a world of computers can do harm as well as good."[14] This ambivalence, he argued, rendered the creation of a Center for Excellence in Humanistic Computer Studies all the more pressing. And yet this ethical ambivalence would only grow starker as other co-founders of the Media Lab willingly seized on the Reagan Administration's interest in funding "flexible technologies", technologies that could lend themselves to both military and civilian applications. This flexibility enabled computer technologies to be sold to South Africa—against international weapons embargoes—for both educational and military ends.[15] Papert alluded in his proposal to the possibility of MIT linking up with the United States' largest existing initiative for implementing computers in the classroom: the "Programmed Logics for Automated Teaching Operations", referred to commonly as PLATO. At the time of Papert's proposal, PLATO was embarking on a large-scale operation to introduce computers into black South-African colleges, so as to help render viable the contradictions of apartheid governance, circumventing the fact that an exclusively black faculty could not logically serve as a legitimate authority of anti-black governance.[16] If writing, according to Plato, runs the risk of substituting its own deaf dictums for truth-seeking discourse, it can be seen that the embrace of PLATO in South Africa aimed to achieve precisely this, enabling apartheid's simultaneous production of distance and extension, muteness and transmission, between sovereignty and subjects.

The contrast between PLATO and Plato is two-fold. In

13 Papert, "Computers and People: A Concept of a Center of Excellence in the Study, Development, and Applications of Personal Computer Power (1977 Draft)."
14 Ibid.
15 NARMIC, *Automating Apartheid: U.S. Computer Exports to South Africa and the Arms Embargo* (American Friends Service Committee: Philadelphia, 1982)
16 Thomas Bartholomay, *Control Data's Plato Computer and South Africa's Apartheid Education System*, Working Papers (Trenton, New Jersey: Africa Research & Publications Project, c. 1984).

Phaedrus, the boy's knowledge is formed through the course of his wanderings between city and wilderness. Knowledge and thus selfhood necessarily entail this free but guided traversing as witnessed in the back-and-forth dialogue between pupil and teacher, and, more literally, in the movement between one's immediate urban contrivances, which demand certain modes of thought, and the surrounding wilderness, redolent of a different knowledge tied to a remote, mythical past. Against this free wandering between city and wilderness, the apartheid system proscribes movement. Deprived of the right to travel outside racial and ethnic zones, black and Asian subjects had their mobility replaced by a pseudo-mobility: the connectivity effected by computers, which bridge distances while maintaining them and transmits to the inhabitants of bush and ghetto the language and sciences prevailing among the ruling racial class.[17] However different Papert's context and intentions, his proposed method of teaching-through-computers nonetheless suggested a kind of arrest of dialogue and movement, even if far less literally (or insidiously) than in the case of PLATO-South Africa. Computer-aided autodidacticism implies the confinement of the mind within both itself and its technologies of self: no wandering into the "wilderness" external to the mind's predominant techne. Both Negroponte's and Papert's initiatives sought to replace human authority with something far less objectionable: a technological extension of the subject. At the early Media Lab (c. 1980), the concept of the human, drawn from the French Enlightenment, was of an independently self-authorizing individual: his or her independence enabled by non-coercive technologies of self-formation.

Papert's ideas for humanistic computer learning rested on the assumption that individual autonomy—and its partner, autodidacticism (both impossible conditions, at any rate)—were foundational to egalitarian democracy. However, this North American "democracy", premised on autonomous self-determination rather than on social involvement, runs the risk of isolating individuals from a larger body politic and of isolating young people from teachers who could initiate them into the kinds of dialogic inquiry necessary to questioning systems of authority. A distinction needs to be drawn then between so-called *autonomy*, resulting from an education dependent on technological extensions of the user's own thoughts; and, on the other hand, *critique*, which involves estranging inherited truths by pursuing itineraries that lead away from the intellectual ground in which one is normally ensconced. Phaedrus and Socrates travel between *polis* and wilderness, gaining distance from one system of knowledge—writing and, relatedly, rhetoric—so as to responsibly master that system. In order to write and read responsibly and truthfully, one not only must be literate but, furthermore, must understand what writing and reading *do* and how they do it. To understand these technologies of self and their political impacts is to better understand the self's political responsibilities.

Turkle's book, *The Second Self,* stressed that computers were not only extensions of self, but also vehicles through which a child comes to articulate a conception of the human. Certainly, concepts of the human have been formed vis-à-vis technologies of knowledge for at least as long as there have existed any mnemonic tools: not only inscription but also verse, song, spatial diagrams, myths, and taxonomies. The self's technological scaffoldings have, since the existence of language, merged with the mind's own organic structure while, at the same time, offering a ground against which to read what escaped beyond them. The founding members of the Media Lab, however, were interested not only in developing technologies for supplementing and better structuring intellectual processes; they were concerned first and foremost with restructuring social relations. What we witness then is no longer the process identified by Marx whereby relations between "things" (i.e., commodities) come to stand in for relations between people; rather, Papert and Negroponte suggest processes in which dialogic processes of negotiation between people—whether in education or in urban-development—come to be replaced by technological frameworks that make "democracy" or "autonomy" possible in merely rote or atomistic forms.

Papert fully grasped that social equality had to be based on the democratization of knowledge, but he seemed to regard as suspect knowledge that was channeled through the authority of pedagogical institutions. We could contrast this to *Phaedrus,* in which the development of knowledge is strangely bound up with the experience of erotic love. Indeed, what distinguishes the two kinds of love described in this dialogue—one characterized as easy, superficial, and self-serving; the other as ethically and intellectually challenging—is implicitly linked to different modes of learning: One can learn by rote, remaining satisfied with surface comprehension; or one can continually reach out of the familiar and into what is strange and difficult to grasp.

17 It is telling that in the late 1970's when arms sanctions were imposed against South Africa, the curtailment of arms stimulated a torrent of computer imports into South Africa from the U.S. and Great Britain.

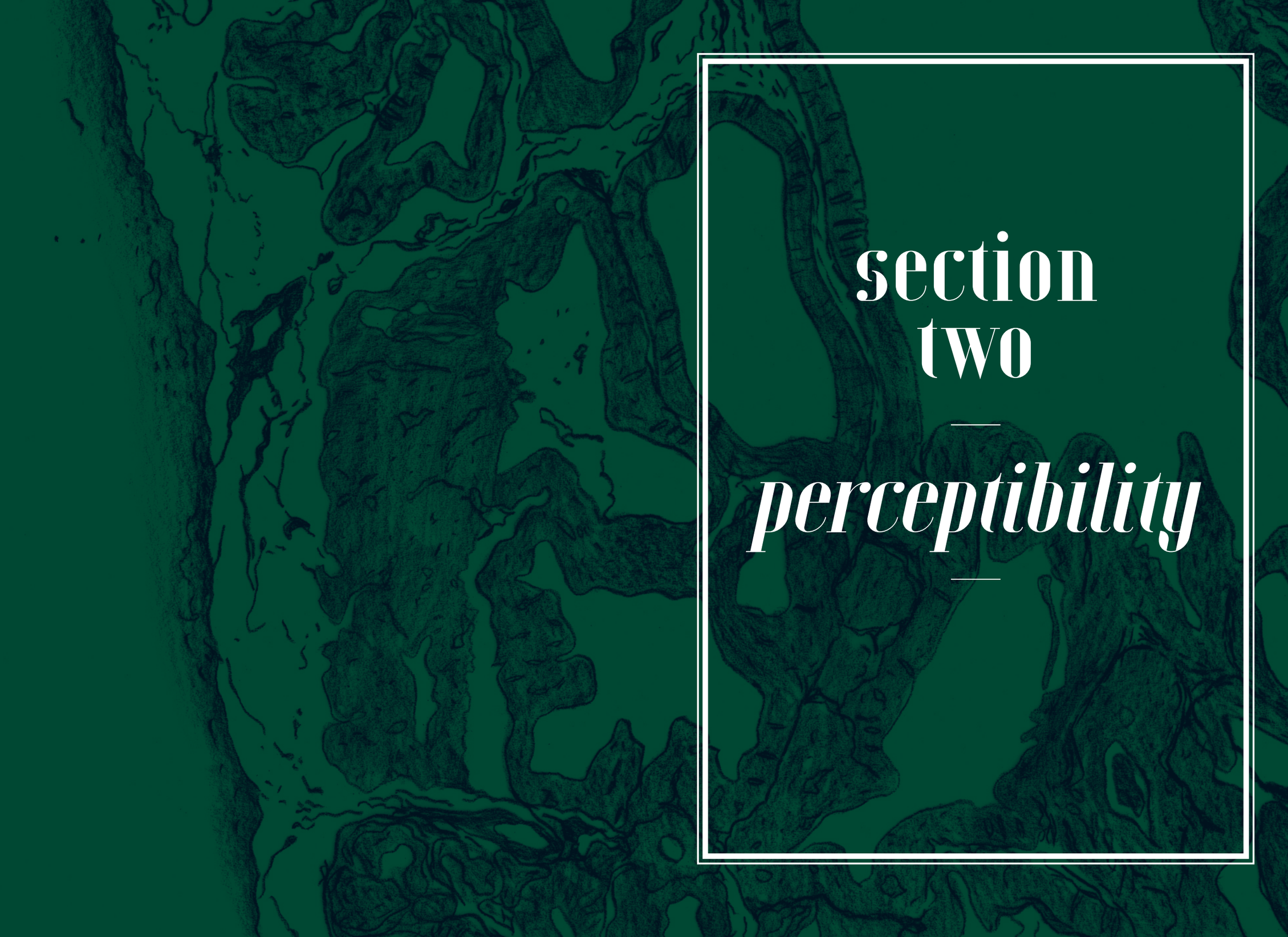
Plato's choice to thus analogize between love and learning can not be merely an incidental to his argument. Rather, the analogy hints at the nature of desire itself which is common to both learning and love, insofar as desire represents a yearning for that which is beyond oneself. Gayatri Spivak's formulation of education as the "non-coercive rearrangement of desires" might beg the question then: What is the nature of the desire that is prerequisite to having one's desires rearranged? Desire, which is always a desire to transgress boundaries of the familiar, puts the pupil in the position to have her desires reorganized similarly to how the world itself is reorganized, through education, vis-à-vis one's comprehension.

It should be noted that Itard, in his initial struggle to educate Victor, decided that an essential, prerequisite task would be to instill in his ward new material tastes and desires, effectively depriving him of the astounding self-sufficiency that had thus far rendered education superfluous to his interests.[18] In proscribing Victor's contact with the forest, whence for years he'd derived all necessities and pleasures, Itard forced Victor into a state of dependency, sociability, and educability. Itard recognized that a person capable of independently fulfilling all his needs had no reason to step beyond the present boundaries of his intellect. Indeed, if education rearranged desires, desires had to first be arranged so that education—and hence further rearrangement—would even be admitted by the pupil. At first, Victor was given material inducements. Subsequent though to his mastery of a few basic operations, the desire of learning for its own sake in many ways supplanted the need for material rewards. That is to say, desire begot a kind of perpetual desire for desire: for reaching beyond old bounds.

While there is no reason to dismiss the many ways in which education-by-computers can help students learn and give them access to things otherwise remote, it is nonetheless hard to ignore the computer's often introverting effects. The computer-as-teacher, as conceived in the 1980's, would seem likely to shape pupils' minds not into purposeful devices for moving beyond facile conceptions, but rather into powerful but useless instruments captivated by a kind of false mobility. That is, because the computer becomes part of one's own intellectual scaffolding, to learn through and by the computer, is to learn within the workings of one's own interior system, regardless of the subject matter being acquired. And, as with PLATO, this kind of containment may not only apply to the individual's intellectual processes; it can be extended quite easily to other forms of containment.

As we witness in much of Turkle's work, the current discussion of the so-called post-human has often situated the questions posed by computational technologies at the level of private psychological experience, rather than at the scale of broader political-spatial relations. According to Katherine Hayles, for example, the individual's experiential and affective sensorium is etiolated by technologies that privilege information over embodied modes of knowledge. But I would argue that the theoretical problems posed by computer-human relations have less to do with phenomenological deprivation than with the potentials for reinforcing class- and race-based forms of discrimination, such that the effects of binaries like Soweto/Johannesburg do not disappear but are allowed to persist, albeit in mediated form, through technologies of exchange. This is, of course, precisely what Papert argued against, and what he hoped to avoid through Humanistic Computer Studies. At present, however, the Media Lab does not offer to its students any serious humanities training. Indeed, Papert's discussion of the dangers of the computer quickly lapsed into silence. And the computer itself is, conveniently mute regarding the politics in which it partakes. Turkle had written of Victor d'Aveyron that, despite his rigorous education, he "never told what he knew. He never told if he knew." The problem with written words, Socrates said, is that they remain silent when questioned. This is not a reason, however, not to question them. On the contrary, it is why dialogic discourse must accompany the techne of writing and reading. Or, put it in more concrete terms, it is why Papert and Turkle were correct in their original diagnosis in the early 1980's: that a Media Laboratory would require a corollary program quite distinct from the inventive, commercial, and military bent of the MIT Media Lab, namely, a program in the humanities that trains the human mind to interrogate its own intellectual technologies.

18 Jean Marc Gaspard Itard, *The Wild Boy of Aveyron*, The Century Psychology Series (New York,: Appleton-Century-Crofts, 1962).

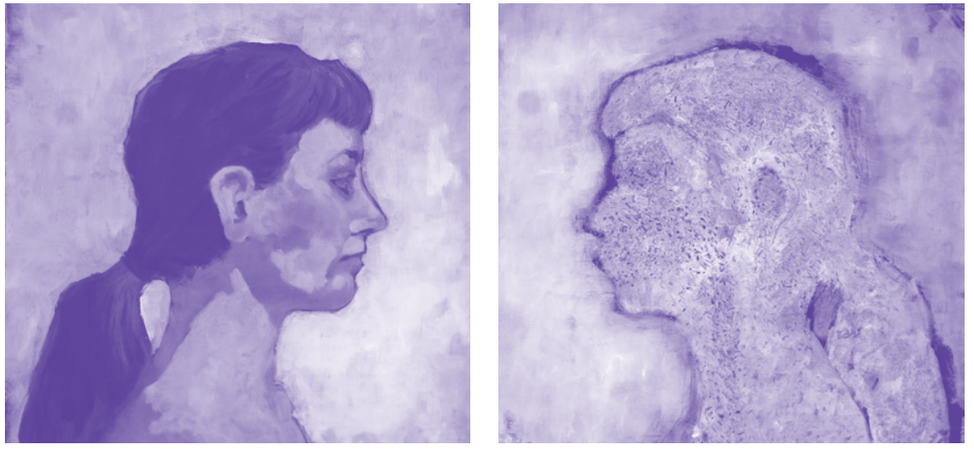


section two

perceptibility

HOMO MICROBIS: THE HUMAN MICROBIOME, FIGURAL, LITERAL, POLITICAL

STEFAN HELMREICH



"Our Self Portrait: the Human Microbiome," Joana Ricou, 2011. Oil on canvas, two panels 16 x 16 in. Image courtesy Joana Ricou.

How do biologists imagine the human being these days? The Human Microbiome Project, inaugurated in 2008 and sponsored by the United States National Institutes of Health, tells us that human bodies are mostly microbial—mostly made up of microbial ecologies: "Within the body of a healthy adult, microbial cells are estimated to outnumber human cells ten to one."[1] What does this mean?

In "The Human is More than Human," a mind-unwinding essay in his 2013 book, *Cosmic Apprentice*, science writer Dorion Sagan provides an uncanny take on our microbial constituents, delivering friendly and fiendish facts about human biological heritage: we are threaded through, more than we know and have known, with microscopic companion species and stranger strains.[2] No longer merely the lineal descendants of previous generations of earlier hominoids, anthropoids, mammals, chordates, animals, and so on, we humans are sideways mash-ups—Frankensteins—made up of a welter of teeny microbial friends and enemies. The traces of relic viruses and companion microbes are embedded in our genomes, our cells, ourselves. Microorganismic relations survive and thrive in our blood and guts.

We could call the viral, microbial, and fractal figure of this multiplied body that Sagan describes as something like "Occupy *Homo sapiens*." Sagan exhorts us to reënvision ourselves as the 90 percent—the 90 percent microbial, that is ("there are," he writes, "ten of 'their' cells in our body for every one of 'ours'"[3]). The remaining 10 percent of our putatively "human" cells are over-esteemed in his view, dominating our vision of human nature for far too long.

It is an arresting figure, this entity that we could name *Homo microbis*.

I want to zoom in on some of the rhetoric that Sagan winds into his accountings of this figure. Next to the *figure*, then, the *literal*. Sagan writes of the thickness of our microbial complement that, "we literally come from messmates and morphed diseases."[4]

But what is it that "literally" means?

The OED tells us that "literal" is originally theological: "Of or relating to the 'letter' of a text."[5]

Taking things literally, then: that which is "literal" points us to *text*, to more representation, and not, perhaps, to the ultimate materially of things, as we often use the word "literally" to mean.

So: what are the "letters" of the organismic text that describes the swarm of tiny critters that make up *Homo microbis*?

Well, the letters of this text come to us from the binomial nomenclature of Swiss botanist Carolus Linnæus, who in the 1750s established the two-termed form *Genus species* to designate living things, as in, e.g., *Homo sapiens*. This Latinate system of naming is the one that Sagan calls upon in his essay to describe our microbial familiars. He tells readers about microbial critters with mouthful names like *Campylobacter jejuni*, *Toxoplasma gondi, Candida albicans*, and *Convoluta rascoffensis*, organisms that variously swarm our insides and outsides. Sagan quotes Clair Folsome as offering that humans are a "seething zoo of microbes."[6]

1 The Human Microbiome Project, Overview: http://commonfund.nih.gov/hmp/overview.aspx

2 Dorion Sagan, *Cosmic Apprentice: Dispatches from the Edges of Science* (Minneapolis, MN: University of Minnesota Press, 2013). This essay of mine developed from a conversation with Sagan at the 2011 meetings of the American Anthropological Association. A video of that conversation can be found here: http://www.culanth.org/?q=node/509.

3 Sagan, 19.

4 Ibid.

5 Definition 5 a. of "literal," Oxford English Dictionary, online edition, accessed April 18, 2013.

6 Folsome, quoted in Sagan, 18.

In a kind of oblique support of Sagan's argument, though, one might point out that there is actually nothing "literal" at all about names like *Toxoplasma gondi*, *Candida albicans*, or *Campylobacter jejuni*. The meanings *in* the genus names writhe against their staid Latin boxiness. If to be literal means to be "free from metaphor, allegory, etc.," these are literalities that are *not at all* literal—they swarm with rhetoric. Think, then, about the "literal" translation of these microbial binomials:

Toxoplasma gondii: "crescent-like mold from gundi rodent"
Candida albican: "a glistening whiteness"
Campylobacter jejuni: "fasting bent stick"

These Latinate heterogeneities in view, one might now revisit the Latin *Homo sapiens*. Are "we" humans still "thinking man," or is it time for the "human" to be renamed?

Renaming *Homo sapiens* has been, no surprise, a language game of long vintage in political philosophy. There have been many offerings, most prominently:

Homo faber (making man), elaborated by Hannah Arendt in 1958 to draw attention to human creativity, but with earlier precedents and mentions from Appius Claudius Caecus, Benjamin Franklin, Karl Marx, Henri Bergson, and Max Frisch.[7]

Homo ludens (playing man), celebrated by historian Johan Huizinga in 1938, but named earlier by Friedrich Schiller in 1795.

Other candidates have been *Homo amans*, *Homo reciprocans*, *Homo oeconomicus*, *Homo grammaticus*...

These all do different sorts of work, though all make some *cultural* activity the subject of the species slot. What I have called *Homo microbis* is a strange folding back, a strange back-to-the-*biological* move. My own playful splice here might be seen as part of the same historical moment that has lately given us such forms as the "biological feminism" of Elizabeth Wilson, in which Wilson mines new biological knowledge for critical resources with which to think and unthink naturalizations and denaturalizations of gender.[8] This biophilia is part of the same historical moment as Icelandic pop star Björk's 2011 album, *Biophilia*, in which she sings:

7 Hannah Arendt. *The Human Condition* (Chicago: The University of Chicago Press, 1958).
8 Elizabeth Wilson, *Psychosomatic: Feminism and the Neurological Body* (Durham, NC: Duke University Press, 2004).

Cover art from Björk's Biophilia, Polydor Records, 2011.
Image courtesy Björk Management.

> *Like a virus needs a body, as soft tissue feeds on blood, some day I'll find you — one day I'm there. Like a mushroom on a tree trunk, as the protein transmutates, I knock on your skin—and I am in.*[9]

What are the politics—and not just the aesthetics—of this moment? The politics of Sagan's reading of the microbiome are clear: a call to reposition, to rethink, to defamiliarize the "nature" upon which we have believed human biological being to rest. I would like to join Sagan in making explicit the political dimension of this *figure* of the multiply biological.[10]

Anthropologist Heather Paxson says that the ascendancy of the microbe—in public health, in food politics, and in many other places—is more than noticing new non-human natures. It is *microbiopolitics*, "the creation of categories of microscopic biological agents; the anthropocentric evaluation of such

9 Björk, "Virus," *Biophilia* (Polydor, 2011).
10 I am indebted in my thinking about the idea of the "figure" to science studies scholar Donna Haraway. In *Modest_Witness@Second_Millennium.FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience* (New York: Routledge, 1997), Haraway writes that "[f]igurations are performative images that can be inhabited. Verbal or visual, figurations can be condensed maps of contestable worlds" (11). Figures — or, for her, in this passage, figurations — are things like the Christ figure, the atom bomb, the fetal sonogram, entities that gather up the concerns, longings, anxieties, and hopes of a people. The microbiome, I am suggesting here, is a new figure on the landscape of biology, gathering up new ideas about species, disease, and community.

agents; and the elaboration of appropriate human behaviors vis-à-vis microorganisms engaged in infection, inoculation, and digestion."[11] Paxson's term is a union of the *microbial* with the *biopolitical*, where the biopolitical is a concept, following Michel Foucault, that describes how politics has come in the last two-ish centuries to operate through the substances and sensibilities of biology (take *eugenics*, those programs of human breeding or genocide aimed at transforming populations so as to be in line with political and social ideologies, as the most extreme, negative example of biopolitics. More subtle forms might include particular genres of prenatal testing and counseling. More benign versions might include some kinds of socialized health care).

Taking off from Paxson's microbiopolitics, I want to fuse biopolitics with a term from evolutionist Lynn Margulis, *symbiogenesis*, which she coined to encapsulate the idea that evolutionary biological novelty emerges not just from Darwinian descent with modification, but also through the symbiotic fusion of different kinds of cells and organisms (as with, for example, the mitochondria in our cells, which were once free-living, oxygen-respiring bacteria).[12] The term I suggest, *symbiopolitics*, refers to the densely political relations among many entangled living things—not just microbial—at many scales. Symbiopolitics is the politics of living things coexisting, incorporating, and mixing with one another.

But let me say more about politics—and offer that a clear politics of the "human" do not necessarily follow from redescriptions of the biological. Such politics can be progressive, retrogressive, liberatory, oppressive, strange, and familiar—all at once.

On the side of the strangely familiar, take, for example, some recent scientific work that writes *race* into the microbiome. In a 2012 piece entitled "The Interpersonal and Intrapersonal Diversity of Human-Associated Microbiota in Key Body Sites," we read, as if in a Lovecraftian story in which old legacies won't go away, that it is possible to characterize the microbiomic diversity of Caucasians, African Americans, Hispanics, and Asians (Native Americans are absent, a relief in some ways, though for the wrong reasons). The authors of this piece suggest that, "The vaginal communities of Asian and Caucasian women were more often dominated by lactic acid-producing *Lactobacillus* species than those of Hispanic and African American women" but then

11 Heather Paxson, "Post-Pasteurian Cultures: The Microbiopolitics of Raw-Milk Cheese in the United States," *Cultural Anthropology* 23(1)(2008): 15-47, at 17.

12 Lynn Margulis, ed., *Symbiosis as a Source of Evolutionary Innovation: Speciation and Morphogenesis* (Cambridge: MIT Press, 1991).

do not tell us how those categories were selected or defined (though one imagines they derive from a clumsy attempt to be "inclusive" of human diversity, figured through US census categories), why they might matter, or, importantly, which direction the causal arrows might go—leaving the reader to fall back on phantasmatic notions of these categories as somehow foundationally biological. This is a microbiomization of race.[13]

Would it make sense to take a more sophisticated approach and ask how social categories like race and processes like racism—and its attendant stresses, deprivations, health disparities (and, in some cases privilege)—can reach into people's biologies and reshape their microbiomes? Only up to a point. As Jonathan Kahn (personal communication) suggested to me, this would simply add up to "the molecularization of environmental influences on race." Another problem with this sort of corrective it that it itself participates in reifying "the microbiome," as though it is a thing rather than a description.[14]

Or take the politics of sex and gender (Recall the *Homo plus* formulations I mention above. Why never *Femina sapiens*?[15]).

Thinking about gender, consider some of the new "facts of life" to which Sagan alerts his readers, "facts" that tangle with sex/gender and the transgression and unwinding of that binary. Take for example his suggestion that,

> *Multiple insect species transform because of Wolbachia bacteria. The genus is nearly ubiquitous in insect tissues. Too big to fit within the sperm of insects, infective Wolbachia can confer parthenogenesis on insect populations, that is, transform a population with two genders into one that is all females, this of course to the advantage of the "selfish" bacteria, as the sperm bottleneck impedes their propagation. By disabling the gender-bending bacteria, antibiotics can make separate species of jewel wasps interbreed again.*[16]

I am not so certain, though, that "gender" is the right optic to describe the dynamic in motion here. Rather than saying that

13 See Luke K. Ursell, BS Jose C. Clemente, Jai Ram Rideout, Dirk Gevers, J. Gregory Caporaso, and Rob Knight. 2012. The Interpersonal and Intrapersonal Diversity of
Human-Associated Microbiota in Key Body Sites. *Journal of Allergy and Clinical Immunology* 129(5): 1204-1208, at 1206-1210.

14 Thanks to Alondra Nelson and Hannah Landecker for helping me think this through.

15 Or almost never. The one instance I've found is in the name of a Colombian feminist studies journal from 1982 (Bogotá, Colombia: Centro de Documentación y Communición Feminista)

16 Sagan, 23.

Wolbachia are "gender-bending," we might rather say that they are *sex*-bending.[17]

Why *sex* rather than *gender*? Because we should not make "gender" always and everywhere reduce to "sex" and be about reproduction.

I think here of a critique delivered by queer and trans theorist Eva Hayward of the work of sociologist Myra Hird in *The Origins of Sociable Life*, a book that seeks to draw sociological lessons from the doings of microbes. In that book, Hird advances the idea that "gender" might be used to refer to "features that bring organisms together to share DNA and/or reproduce"—which mode of thinking about the matter then presses her to suggest that "The *mushroom Schizophyllum commune* has 27,000 genders, encoded by 'incompatibility genes' that come in many versions (alleles) on different chromosomes."[18] Hayward argues that Hird's framing here makes gender into a simple proxy for sex—not heterosex, to be sure, but still sex as reproduction.[19] Calling on the work of Kath Weston, Hayward goes on to say that "binary ontologies of sex–gender are not necessarily destabilized by the addition of a third—or even a fourth or fifth."[20] As Weston shows in her 1996 text on lesbian identity and community, *Render Me, Gender Me*, gender—whether butch, femme, or studmuffin—can attach to race, class, nation; that is, to many things other than reproduction.[21]

Rather than gender-bending—or, for that matter, sex-bending—it might be useful to consider what "Eva Hayward and Lindsay Kelley call 'tranimals'—enmeshments of *trans* and *animals*, critters that cross or queer normative sex and gender configurations."[22] Think, for example, of sequentially hermaphroditic fish or of coral. Sympathetically symbiopolitical, I offer that *trans-* can do lots of biological and social work, unwinding the naturalization of both sex and gender (Sagan mentions another figure with which it might be useful to think: the mixture of the plant and the animal, the *planimal*, of which the example he gives is a green slug that produces chlorophyll[23]).

17 See S. Eben Kirksey and Stefan Helmreich, "The Emergence of Multispecies Ethnography," *Cultural Anthropology* 25(4)(2010): 545-576, particularly at 559.
18 Myra Hird, *The Origins of Sociable Life: Evolution after Science Studies* (London: Palgrave Macmillan, 2009), 100-101.
19 Eva Hayward, "FingeryEyes: Impressions of Cup Corals," *Cultural Anthropology* 25(4)(2010): 577-599, note 11.
20 See Kath Weston, *Gender in Real Time: Power and Transience in a Visual Age* (New York Routledge, 2002).
21 Kath Weston, *Render Me, Gender Me: Lesbians Talk Sex, Class, Color, Nation, Studmuffins...* (New York: Columbia University Press, 1996).
22 Kirksey and Helmreich, 559.
23 Sagan, 24.

Just to confuse things productively, let me offer another confounding sex/gender swirly: fetal microchimerism. As Laura Fugazzola, Valentina Cirello, and Paolo Beck-Peccoz describe it in a *Nature Reviews Endocrinology* article from February 2011, "Fetal cell microchimerism is defined as the persistence of fetal cells in the mother after birth without any apparent rejection. Fetal microchimeric cells (FMCs) engraft into the maternal bone marrow for decades after delivery and are able to migrate to blood and tissues."[24] This means that women who have been pregnant have been biologically—or, more precisely, cellularly—remodulated by their fetuses. Pretty interesting, but does it *mean* anything in itself? Should it remind us of the Wari of Peru, noted by anthropologists for a kinship system in which incorporation of kinspeople—though the food they give, and sometimes, through such practices as mortuary cannibalism—makes relation? Or, as one colleague worried to me, might a biologically reductionist account of fetal microchimerism just be used to naturalize or newly justify feminist psychologist Carol Gilligan's 1982 essentialist claim that women are more relational than men?[25]

The biology, as astonishing as it is, does not tell us what it will mean.

Why do accounts like those of Dorion Sagan have the purchase they do on contemporary readerships in popular science and critical theory alike? Why the interest in multispecies, interspecies, and transspecies now? Why is this erosion of human organismic integrity exciting to some social scientists and humanists (to say nothing of natural scientists)? Why this biological "posthumanism" now? Sagan suggests that the "nonhuman" is coming into view because of the increasing stress on planetary resources by the human species. In this context, he suggests, we would do well to recognize that "the human is more than human." But I would add that we must recognize an additional fact—that "biology" does not speak for itself, about humans or nonhumans. The biological is more than biological.

24 Laura Fugazzola, Valentina Cirello, and Paolo Beck-Peccoz. "Fetal microchimerism as an explanation of disease," *Nature Reviews Endocrinology* 7(2011): 89-97, at 89. For a social analysis, see Martin, Aryn, "Microchimerism in the Mother(land): Blurring the Borders of Body and Nation." *Body & Society* 16(3)(2010):23-50. Thanks to Lynn Morgan for alerting me to this work.
25 Carol Gilligan, *In a Different Voice: Psychological Theory and Women's Development* (Cambridge: Harvard University Press, 1982).

REFASHIONING THE MICROBIAL BODY
MARIEL VILLERÉ

Definitions of "work" and "self" occupy a blurry territory for Sonja Bäumel. In her 2012 project, *Expanded Self,* bacteria sampled from Bäumel's body formed a bacterial life autonomous from its author, who had placed her own native microbes from single day in a sterilized environment between two panes of glass. In 2009, clouds of multicolored fungi grew from her skin's flora bacteria in a giganticized scientific instrument on her living room floor, representing a second self –both an artifact of the moment of making and a separate trajectory of life parallel to her own, both occupying the same living space.

Her hand, having made a duplicate of her own body and thus blurring the territory between maker and made, evokes a semantic distinction between the accepted term *Homo sapien* (wise man) and another definition of human, *Homo faber* – man the creator.

Translating 'human' as *Homo faber,* one who makes a useful tool from a found object, necessitates the process of production to define human against the thing that is produced. Without abandoning *Homo sapien,* philosopher Hannah Arendt defined *Homo faber* as a contemplation of process, the mind's role in the body's production, necessitating unity between head and hand. But what of the body's self-production– that is, of bacteria– when interfered with by conscious production and intervention by the hand?

Bäumel uses her own body as subject and as a tool to understand how she operates in the larger world. She explores the physical territory between the body and the environment—exploiting the definition of skin in considering the "secret(ive) layer", as she calls it,[1] of the bacterial world atop, and within, the body's membrane. Borrowing Derrida's theory of the parergon,[2] Bäumel's work considers the skin an expand-

1 Sonja Bäumel, "Human Biome/Synthetic Biology and Design" (presented at the Institut für Industrial Design 2 der Universität für angewandte Kunst Wien April 9, 2013), http://www.youtube.com/watch?v=JorQlui9JJo.

2 Derrida writes himself into the irrecuperable absence in his book, *The Truth in Painting* (1987). Borders, he argues, are unstable and therefore fictional because of the ever-present distance between two bodies, between the *ergon* and the *parergon.* The border helps create an idea of difference and separation between entities–it in fact helps create the idea of entities as such. Believed to be there, and clearly demarcating difference, the border can never actually be reached.

Textured Self by Sonja Bäumel, 2011. A work commissioned by the Textielmuseum Tilburg

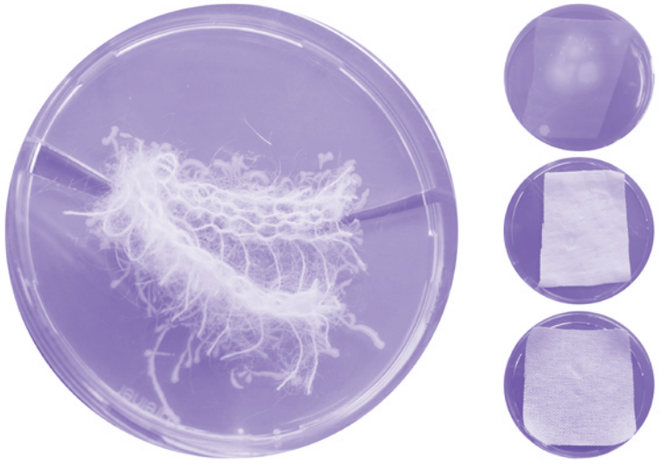
ing "living landscape" without a true limit or contour, and instead, part of a symbiotic ecosystem between the body's internal organs and the external environment. In the process of making *Expanded Self*, a fissure emerged to expose the space between the bacteria and the pane of glass. Bäumel considers this crucial to the integrity of the work, an artifact of the story and the interface between life and art, between body and environment.[3] While documentary, Bäumel sees potential in the bacteria on our skin as a hidden platform for new and unexpected body-environment interfaces–that is, interpretive clothing.

Sonja Bäumel's background in fashion design informs her later work that emerges from scientific data and "mediates between art and science, fashion and science, design and science, between clothes and body, between fiction and facts."[4] Working alongside scientists in the laboratory, she discerns scientific information to create visual interpretations, which continually feed back into her research through making.

Expanded Self by Sonja Bäumel, 2012

3 Sonja Bäumel, "Human Biome/Synthetic Biology and Design" (presented at the Institut für Industrial Design 2 der Universität für angewandte Kunst Wien April 9, 2013), http://www.youtube.com/watch?v=JorQIui9JJo.

4 "About Me," Sonja Bäumel, accessed November 2013, http://www.sonjabaeumel.at/info/about-me.



Bacteria Textile Experiments by Sonja Bäumel, 2009
photo credit: Sonja Bäumel

Engaging the emerging field of synthetic biology, Bäumel transforms a useful "material" for the body's ecosystem, bacteria, to serve a second purpose, clothing, which previously has been made from material found elsewhere. Allowing the *made* to emerge from the very body of the *maker*, she has redefined self and work as a diametric relationship in an infinitely reversing loop.

Although invisible without scientific tools, microbes make up a larger percentage of human bodies than "human cells" by a factor of about ten. Further, the body's "microbiome" is composed of 3.3 million genes, while the human envelopes only 20-25,000 genes.[5] These numbers invite questions of "who feeds whom?" or "who *makes* whom?" Bacteria and fungi on and in our bodies protect us from illness and disease—but Bäumel asks if we can harness these numbers and make the human microbiome visible, potentially offering visible and adaptable protection to the body.

The artist's critical and cultural perspective gives science an opportunity to imagine, and therefore question, existing definitions within the scientific domain. Arendt's theory that humans can know only what they create themselves gives credit to Bäumel's series of self-portraits in thread and bacteria that she bred (on and off her body) as experimental

5 Baoli, Zhu, Xin Wang and Lanjuan Li, "Human gut microbiome: the second genome of human body." *Protein & Cell* 8 (August 2010): 718-725.

investigations of the hidden connections between humans and the microworld. While making visible what we are most often unaware of, the artist has created a tool to interact with scientists through visualization and tactility to expand scientific findings and their communication to other bodies of knowledge and citizens.

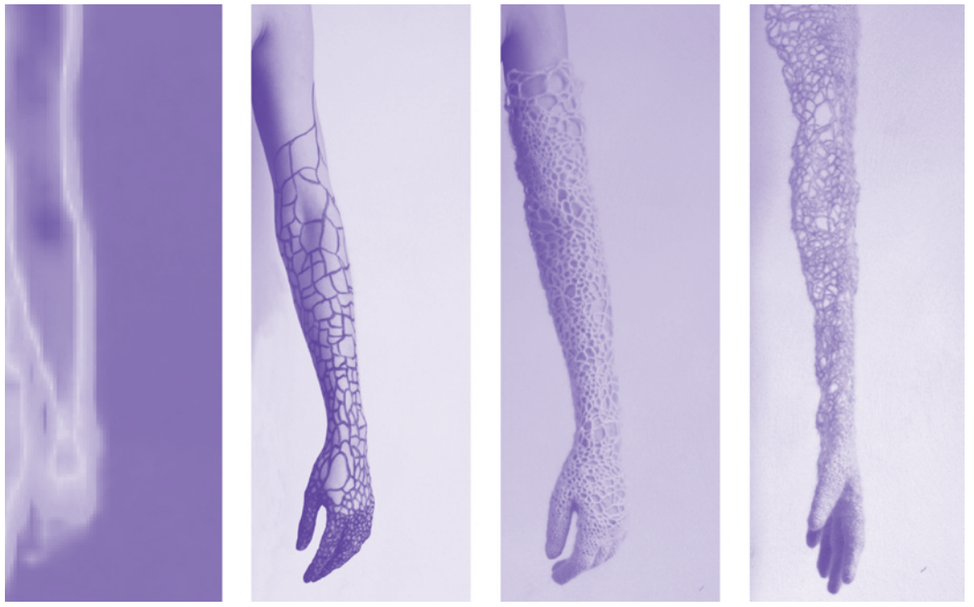
As *designer*, Bäumel intercepts biology's process to craft a parallel, or mock, microbiome. Once removed from the living organism the artist's body is consciously and visually articulating another, distinct body as an adaptable proxy. The artist finds herself in the same existential predicament as author Paul Auster's character, Quinn, in the short story "City of Glass," whose work is a vessel for life. Continuously slipping between presence and absence and protagonist and author of his own story, Quinn and his work as both a writer and a private eye detective exist reciprocally in a relationship that unravels as the story is read. Auster appears in the narrative and Quinn's environment, work, and eventually, *self,* disappear in response.[6] Auster's short story winds through the phenomenon of creating work that operates and even reproduces autonomously outside of the author's control, and ultimately, in the service of the author. Bäumel uses her own body to expose the active mutual production between microbes and human cells with a visually augmented skin. Once placed atop the living organism to render the invisible visible, a different set of needs is addressed.

The aforementioned *Oversized petri dish* is part of a larger series of work named *(In)Visible Membrane*, which also includes *Crocheted Membrane, Bacteria Texture, Visible Membrane I, Bacteria Textile* and the *(in)visible film. Visible Membrane I* challenges ideas of clothing as camouflage, protection and decoration by wrapping a mannequin with highly reactive wool excluding a window into an exposed belly, where a petri dish displayed the reaction between the bacteria on the skin with the wool. This project, of course, introduces new questions in the model as mannequin, with a false skin. If not abiogenesis, the bacteria must be transposed from another living body. Still, the work conveys the message that we should harness the "existing invisible infrastructure on our skin"[7] and visualizes Arendt's understanding of *Homo faber* as "metabolism with nature."[8]

6 Paul Auster, "City of Glass" in *The New York Trilogy* (New York: Penguin, 1985), 9-10.
7 "Visible Membrane I," Sonja Bäumel, accessed November 2013, http://www.sonjabaeumel.at/work/bacteria/visible-membrane-i.
8 Hannah Arendt, *The Origins of Totalitarianism* (New York: Schocken, 2004), 612 and 628.

Visible Membrane I by Sonja Bäumel, 2009
photo credit: Rene van de Hulst

Drawing inspiration from the behavior of the bacteria she studies, Bäumel reimagines clothing as a responsive layer that can adjust to variations in temperature in the same way as internal metabolic processes. Her graduate thesis at the Design Academy Eindhoven reframed clothing as a membrane with the same type of knowledge as the skin bacteria populations unique to each person, flexible to morph in different environmental conditions. A crocheted open system with variable apertures and densities for use in different climates developed from her research on the sensitive slime fungi, which have no cell walls and react quickly. Her concept of clothing does not derive in the same way as most fashion design, from shape or historically patterned form with embedded social hierarchy and material richness, but is instead determined by the needs and sensations of the human body—performing in the same way that bacteria populations individually respond. One of the key phenomena in Bäumel's latest body of work under the title *Metabodies* is quorum sensing, low-threshold communication among bacteria that enables them, by means of chemical reactions, to jointly regulate the number of bacteria in a particular environment and to adapt their "behavior" accordingly.



Crocheted Membrane by Sonja Bäumel, 2008/09
photo credit: Wing Lam Kwo

Crocheted Membrane by Sonja Bäumel, 2008/09
photo credit: Maurizio Montal

Crocheted Membrane by Sonja Bäumel, 2008/09
photo credit: Maurizio Montalti

Crocheted membrane translates scientific data into a fine-tuned aesthetic language, less coverage on areas where the body needs less warmth and more fabric on cold body zones, determined by the skin's transmission of information to the external, crafted layers. Mimicking the behavior of bacteria colonies, textiles are situated as a visual arbiter between bacteria (sensors for the skin) and the environment.

Unsatisfied by the facts, *Textured Self* (2011) is an interpretation the analyzed data sets in an oversized hand-knit and crocheted body, a new silhouette based on the bacteria found on specific zones of her skin on an isolated day. The piece focuses on 20 body zones and articulates the "microcosmos" into a "macrocosmos" through color, texture and structure. Bäumel writes that she aims "to inspire, provoke questions and confront people with the fact that the human is a hybrid, a super organism" that demands the unique relationships between the different forms of life on the body. In this sense, the bacteria populations are tools to make her work, which is ultimately a tool to communicate the dynamic internal/external relationships of human bodies. Bergson defined human intelligence as "the faculty to create artificial objects, in particular tools to make tools, and to indefinitely variate its makings."[9] Once this work is out in the world, in this case through an exhibition at the Textielmuseum Tilburg, it becomes more than an artifact of the body it represents, but a tool of variable interpretations and considerations of the human composition. Quorum sensing could therefore inform and morph fabric in ways beyond density, but for Bäumel, the question of the body's inherent systems of communication informs her deployment of synthetic biology, rather than the skin driving engineering and programming of new clothing.[10] Bäumel considers the social implications of these dramatic changes in fashion: "How would our interaction change if I could adapt to local conditions? Would social integration occur if I could adapt externally?"[11] The artist has transferred partial agency to the work by separating from her skin in a search for self.

9 Henri Bergson, *Creative Evolution,* tr. Arthur Mitchell, (New York: Henry Holt and Company, 1911).
10 Bäumel, Sonja, e-mail message to Mariel Villeré, December 2013.
11 Michael Knoll, "Sonja Bäumel: Metabodies," *Ars Electronica Blog,* July 29, 2013, http://www.aec.at/aeblog/en/2013/07/29/sonja-baumel-metabodies/.

Translucent Bodies

—

Simone Ferracina

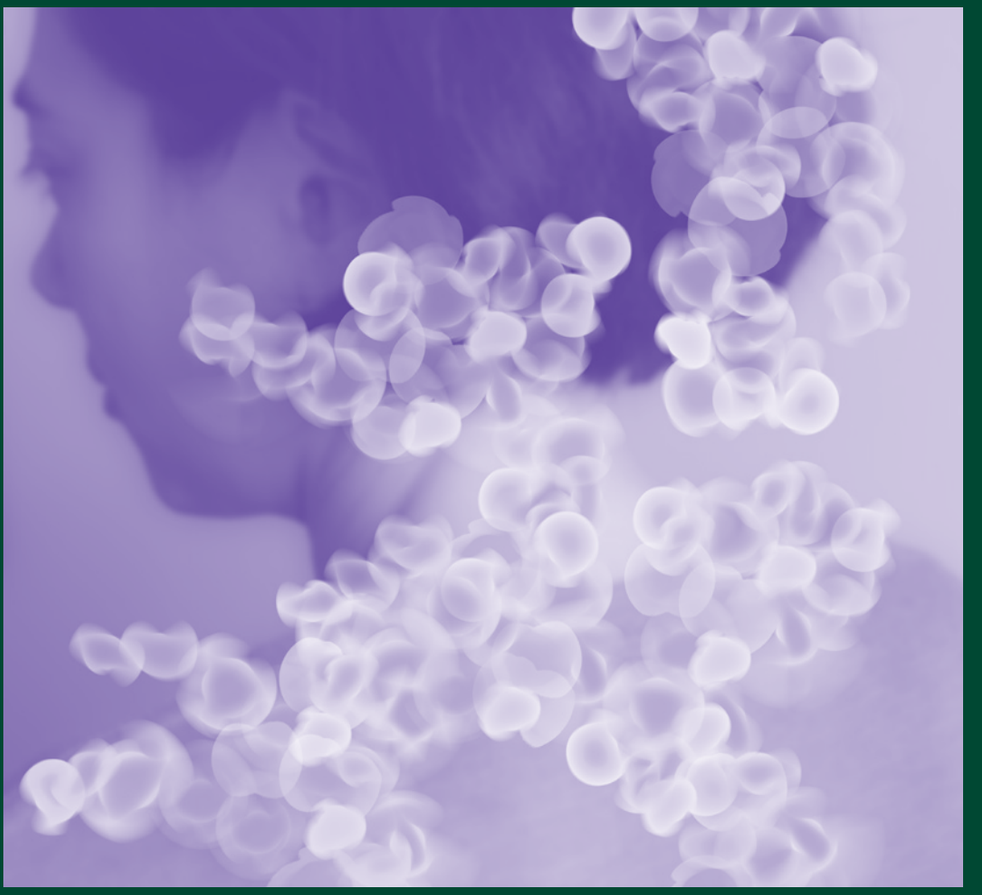
Colouration is not a consequence of external stimulation, but of internal processes in the organism. The animal changes colour to "express a particular interiority". The colouration of the skin constitutes a code: the other members of the species decipher the meaning of the message. Cephalopods "speak through the skin". . . [they become] to other participants of the species a mere informative surface. It is an extremely "opaque", inter-specific communication process.

Vilém Flusser, Vampyroteuthis Infernalis[1]

The capsules were whitish and slightly see-through. Inside, she could detect a metallic dust of nanobots, faintly moving. She filled a glass with water, placed one capsule on her tongue, and swallowed. The Immersive Vision Interface (IVI) was switched on, and in minutes the show began.

First it was cardiac broadcasts—concentric rays throbbing to the rhythm of her heartbeat. Then temperature readings infused her skin with purple, red and orange tones. Fractal meshes surfaced from her flesh, switched on and off by synaptic messages. Chemical shapes gravitated around her limbs, shrinking and dilating, shaking and dancing. Bacterial fluctuations enveloped her body in a liquid sheet of light.

The "Body Hack"—a software originally developed by a twenty-something working in the fashion industry—repurposed diagnostic nanobots to produce real-time visualizations of the human body. It transcoded the interior ecologies and autonomic rhythms of our organism into spontaneous, immersive digital graphics. Although the software became, almost immediately, the most widely adopted digital garment app for optoelectronic channels, it took several weeks for users to discover and embrace it as a new kind of language.



Microbial Glimmers.

Intersubjective

Would her electronic garment signal sadness, anger and frustration? Would color changes and morphological transformations betray an accelerated heat rate or high adrenaline levels? "I'm being hacked, taken over by my own biochemistry," thought Maya. Yet, she was fascinated by the slippery expressivity of the shapes appearing in her field of view, by their strange pirouettes—and eager to interpret them. After work, she spent most waking hours in front of the mirror observing her innermost feelings being plotted in real-time by algorithms—drawing links between internal emotions and external emergences. That's how Maya discovered a communicative dimension between intentionality and metabolism. That's how she learned this liquid, collaborative and uncanny semantics.

Mood Constellations.

Endosubjective

Observation did not help when it came to monitoring her own health. The body communicated independently from consciousness, extruding grammars of electrical signifiers too complex and opaque for Maya's untrained eye. Her friend Ross had studied the interpretation of what medical doctors now commonly called the "EM" (Exploded—not Electron—Microscope), and had even helped streamline some of the programming code. "Sometimes I wish I didn't know how to read the EM." He would tell her. "Sometimes, I wish I could not see in its drawings the ironic beauty of pain and disease."

Botanic Messaging.

Transsubjective

Maya couldn't forgive herself for clumsily spilling nanobots in the garden while carrying groceries. "As if maintaining an augmented body weren't expensive enough!" she grumbled. Then, a few days later, an unexpected digital overgrowth appeared in the garden. Pink mosses sprouted in mid-air; metamorphic weeds swayed between the leaves. Maya sat outside, marveling at these technologically mediated extensions. In them, she could recognize—in the bushes, flowers and soil outside of her suburban home— the same chemical and biological languages described by her own body; the same punctuated rhythms, electrical swirls and bacterial networks. Like a soil or a lake, her human body too was an ecology; one supported by delicate symbiotic relations, which extended well beyond the limits of her skin. She remembered Virilio: "Human comes from the word humus. Humus speaks of humility."[2]

1 Vilém Flusser, *Vilém Flusser's Brasilian Vampyroteuthis Infernalis*, ed. and trans. Rodrigo Maltez Novaes (New York and Dresden: Antropos Press, 2011), 42.
2 Paul Virilio, Grey Ecology, trans. Drew Burk, ed. Hubertus von Amelunxen (New York and Dresden: Antropos Press, 2009), 40.

Image Credit: Simone Ferracina (all images)

section three

cognition

COGNITION IN THE FLESH ...THE HUMAN IN DESIGN

HARRY FRANCIS MALLGRAVE

Ephesus, Turkey. Photograph by author.

> *The individual human subject is the encultured bodily subject. In this way the knowing and feeling subject is not the brain in the head, or even the brain plus the body, but the socially and culturally situated person, the encultured human being.*
>
> Evan Thompson, *Mind in Life*[1]

Let's begin with a seemingly simple question. How does the encultured bodily subject, to use Evan Thompson's epithet, experience architecture?

If one were to survey the history of Western architectural thought—and one need not recount the writings of Vitruvius, medieval abbots, Alberti, Piranesi, Boullée, Bötticher, Giedion, or Charles Jencks to make this point—one would have to conclude that we experience architecture primarily through its representational values. Architecture reflects ideas, and ideas are things that appeal to our rational understanding. The unstated tenet behind such a belief is that we are thinking beings quite distinct from other animals, culturally set apart by our unique powers of reason and conceptualization.

1 Evan Thompson, *Mind in Life: Biology* (Cambridge, MA: Belknap Press, 2007), 411.

But what would happen if we were able to empty architecture of all of its semantic content? Would we experience anything? Of course we would. Martin Heidegger, for one, noted that we do not simply confront "things" simply in a symbolic way. We are "beings-in-the-world," thrown there in fact, with primitive moods and emotions, as well as with particular skills by which we understand or cope with things around us. Things are not abstractions waiting to be interpreted but "equipment" pre-theoretically defined by their manipulability or "handiness."[2]

The psychologist James Gibson amplified this point by noting that perception is no passive sensory activity of recording data for the "thinking" brain to assimilate. At its very inception perception is the engagement of the whole organism moving within an environmental field: exteroception through proprioception. It is already an act of conceptualization because the organism and the environment are reciprocal in their connectedness. Similarly, Gibson insisted that the mental environment cannot be separated from the physical one, "as if there were a world of mental products distinct from the world of material products."[3] He termed his thesis of direct perception an "ecological psychology." More recent theories on the origin and embodied nature of language add further support to this contention.[4]

Our much better understanding of our evolutionary history over the last few years has also put these issues into better focus. *Homo sapiens*, strictly defined, came into existence around 200,000 years ago, yet our immediate hominin ancestor, *Homo erectus*, extends our behavioral lineage back another two million years. In this light, the root of all of our presumably superior mental activity extends far into our pre-human past.

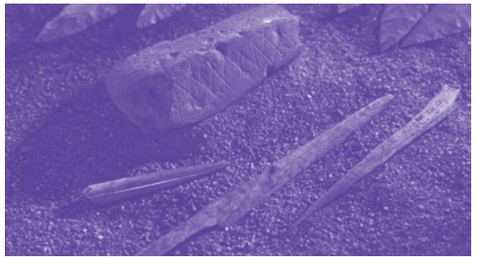
This greater antiquity of our biological heritage has in turn ushered in the new fields of evolutionary biology and evolutionary psychology. Both operate from the premise that the biological structure, sensory apparatus, and the behavioral adaptations of humans were largely crafted in the east African savannahs over the course of the last two million years, against which the events of the past ten thousand years (the so-named 'birth' of civilization) could have done little to alter our behavioral patterns or environmental propensities. These newer models of cognition suggest that our esteemed representational values

2 Martin Heidegger, *Being and Time* (New York: Harper & Rowe, 1962), 97-98.
3 James Gibson, *The Ecological Approach to Visual Perception* (Hillsdale: Lawrence Erbaum Associates, 1986), 130.
4 See especially George Lakoff and Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980), and *Philosophy of the Flesh* (New York: Basic Books, 1999).

are in fact extensions of organismic activities embedded in our adaptive evolutionary codes, which raises some interesting questions about our built environments, particularly our more recent ones. If we are biologically fitted to view the world with certain visual or environmental propensities, for instance, should not our built designs accommodate these propensities?

Evolutionary psychologists, such as Steven Pinker, have used this evidence to argue that the modernist values of the early 20th century failed because architects felt free "to write off people's enjoyment of ornament, natural light, and human scale and forced millions of people to live in drab cement boxes."[5] Yet even if he overstates his case, we can no longer deny that we have an underlying biology and human instincts that have been honed over millions of years.

Another group of biologists have been underscoring the "biophilic" implications of this legacy.[6] In the 1970s, for example, the geographer Jay Appleton proposed a "habitat-selection" thesis, which pointed out that in fashioning our made-made recreational environments we often replicate the terrain of our East-African ancestors.[7] He noted that in our urban parks we seek out places of prospect and refuge (where we might survey things or take refuge from predators), we design landscapes with water (a daily human need), loose groupings of trees with broad canopies (allowing distant views and potential places of safety from predators), clear ground cover (to expose immediate hazards), and paths (signs of human cultivation).



Ephesus, Turkey. Photograph by author.

5 Steven Pinker, *The Blank Slate* (New York: Penguin Books, 2002), x.
6 See Stephen and Rachel Kaplan, *Cognition and Environment* (New York: Praeger, 1982); Gordon Orians, "An Ecological and Evolutionary Approach to Landscape Aesthetics," in Edmund C. Penning-Rowsell and David Lowenthal (eds.), *Landscape Meanings and Values* (London: Allen and Unwin, 1986), 3-25; Gordon Orians and Judith H. Heerwagen, "Evolved Responses to Landscapes," in Leda Cosmides et al, *The Adapted Mind* (New York: Oxford University Press, 1992); Stephen R. Kellert, et al (eds.), *Biophilic Design* (New York: Wiley, 2008).
7 Jay Appleton, *The Experience of Landscape* (London: John Wiley, 1975).

Such hypotheses today are hardly startling. We pay more for the upper-story units in high-rise buildings that command a larger prospect, and abundant research has demonstrated the salutary effects of regular contact with nature—whether it be a walk in a park, digging in the backyard garden, or our jaunts to seashores or mountains, where we go 'to recharge our batteries.' A few years ago NASA commissioned a psychological study regarding long-term space travel, seeking to find ways to mitigate the problems of sleep disorders, increased anxiety, social withdrawal, and the depletion of cognitive skills associated with the the sensory deprivation of Antarctic winters. The recommendation was to outfit spacecrafts with digital screens that would regularly rotate colorful images of nature.[8]

Evidence is overwhelming today that even brief exposure to natural light and greenery lowers our blood pressure, calms our tenseness, increases our focus, and more generally promotes happiness. These facts have significant architectural implications, whether for the homes in which we live or the cities in which we dwell—as many landscape urbanists are today acknowledging.[9]

Still another recent discovery of the biological sciences is our new understanding of neural plasticity, which also brings to the fore the issue of human culture. The underlying premise is Donald Hebb's realization, of a half-century ago, that learning is a process of synaptic bonding.[10] When two neurons fire together, growth in the synapse occurs, leading to a greater likelihood that they will fire in the same way under a similar stimulus. Through repeated firings, they will form established patterns or neural maps that become associative networks. If firings become less frequent, growth will deteriorate and eventually the connection disassembles.

Whereas we used to believe that our thinking processes were "hardwired" by the time we reach physical maturity, we now know that this is not the case. The brain, the human organism in its totality, is surprisingly labile, and all learning over the course of a lifetime involves changes the brain's neurological connections. The areas of the motor cortex that controls the movements of the last two fingers of the left hand, for instance, are substantially larger for concert violinists than for those who do not play the violin.

8 Yvonne A. Clearwater and Richard G. Goss, "Functional Esthetics to Enhance Well-Being in Isolated and Confined Settings," in Albert A. Harrison et al (eds.), *From Antarctica to Outer Space* (New York: Springer-Verlag, 1991), 331-48.
9 See Mohsen Mostafavi and Gareth Doherty (eds.), *Ecological Urbanism* (Zurich: Lars Muller, 2010).
10 Donald O. Hebb, *The Organization of Behavior* (New York: John Wiley & Son, 1949).

The implications here are once again far-reaching. On the one hand we can always learn new things and refine our thinking capacities, even increase our IQs as a few studies have shown.[11] On the other hand neural plasticity means that we are more susceptible than we formerly believed to such things as environmental and cultural changes, whether it be the material elements of our built environments (architecture) or the technologies by which we navigate the world. Both, in fact, can enhance or inhibit our perceptual and cognitive processes, and at a much faster pace than conventional evolutionary theory allows. Our better understanding of neural plasticity has spawned an industry of commentators pondering our new situation—ranging from Andy Clark's championing of our cyborgian natures to the concerns of Warren Niedich that we are too easily being manipulated by the culture industry's phatic images.[12]

In any case, I do not think architects yet appreciate the remarkable strides that the biological sciences and humanities have made over the past two decades. For the first time in human history, we are beginning to get a handle on our human natures, and the insights are forcing us to rethink radically the very tenets of our being.

A Few Implications for Designers

A good starting point would be to introduce a notion that has been altogether alien to architectural theory for more than a century—the idea of emotion. In simplest terms, emotion "is the process by which the brain determines or computes the value of a stimulus"[13] Emotions are evolutionary "affect" programs generated in the subcortical areas of the brainstem and limbic system, programs that in part protect our homeostatic processes.

The psychologist Lisa Barrett notes that when an organism encounters an environmental stimulus, the body first produces a "core" affect, an initial state of pleasure or displeasure (valence) arising from how the sensory properties of the stimulus (the environment) affect the organism's vital condition. Neurologically, this core affect proceeds along two closely related pathways, both based in the OFC, the part of the brain's prefrontal cortex tucked just behind the eyes. Without going into the details

11 Sue Ramsden et al., "Verbal and Non-Verbal Intelligence Changes in the Teenage Brain," *Nature*, 479, #7371 (3 November 2011), 13-16.
12 See Andy Clark, *Natural–Born Cyborg* (New York: Oxford University Press, 2004), and Warren Neidich, "Blow-Up: Photography, and the Brain," in *Blow-Up* (New York: Distributed Art Publishers, 2003), 33-102.
13 Joseph Ledoux, *Synaptic Self* (New York: Penguin, 2002), 206.

of these two systems, it is sufficient to say that one system (sensory) assigns a preliminary value for the stimulus and its impact on homeostasis, while the second circuit (visceromotor) modulates the autonomic, chemical, and behavioral response to the stimulus. Collectively, they produce an affective state bound to a particular situational meaning, giving us the disposition to act in a certain way.[14]

When an emotional response to a stimulus is positive, a "hedonic" or pleasure circuit is activated: neural activity involving the brainstem, basal ganglia and amygdala, OFC, anterior cingluate cortex, and insula. When we experience this "flush" of happiness, it is because dopamine has been released into the bloodstream, which rushes through the reaches of the brain and is "felt" throughout our whole bodies. Music, for instance, can ignite "chills down the spine," a process that has been recorded in neuroimaging studies.[15] The interesting thing about this hedonic circuit is that imaging studies have shown it to be set into motion by a wide range of pleasurable experiences: maternal and romantic love, orgasms, a good meal, social acceptance, a beautiful sunset, a smile, and the visual and aural arts. And even though the multisensory experience of architecture today cannot presently be monitored in way that one can measure the impact of a painting or music, we can presume that this circuit is also ignited by a particularly satisfying architectural experience.

Two points are essential to these new emotional models. First, emotions condition our response to our sensory fields or built environments, and they do so pre-reflectively—that is, much of the activity takes place prior to our awareness or "feelings" about events. This is a crucial point because architectural theory, in the last century in particular, has rarely taken human emotion into account. Yet it is important to understand that when we sit back and reflect upon architectural experience, we have in fact already made judgments about such things as the comfort of a door handle or handrail, the ease of a stair riser or tread, the texture of a floor material, the acoustic resonance or visual ambience of a room, the hand of a fabric, the smell of materials, and we do so largely intuitively, or rather, prior to conscious reflection. We also in various ways make pre-conscious judgments about the materials selected, spatial relations, dimensional proportions, scale, patterns, rhythms, tactile values, and even the creative intentions of the architect.

14 Lisa Feldman Barrett, "The Experience of Emotion," *Annual Review of Psychology*, vol. 58 (2008), 373-403.
15 A. J. Blood and Robert J. Zatorre, "Intensely Pleasurable Responses to Music Correlated with Activity in Brain Regions Implicated in Reward and Emotion," *Proceedings of the National Academy of Sciences*, vol. 98 (2001), 11818-23.

The second point is that our emotional response is fundamentally embodied, in the sense that emotions also implicate the sensorimotor areas of the brain related to our bodily movements and corporeal awareness of them. This is a difficult point to summarize succinctly, but we do not simply stand back and, like a movie camera, mechanically record the stimuli before us; rather, if I can invoke a term of Robert Vischer of more than a century ago, we *einfühlen* or "feel ourselves into" this world through our bodies in an immediate way.[16] If we descend along a corridor with a low ceiling, we walk with a crouch. If we enter a spatially luxurious room, we inevitably stand tall and our respiration deepens. If someone of normal height is forced to sit in an economy airline seat, that person will feel trapped and angry. We do so because our bodies are in fact "thinking"—responding to the environmental stimuli.

Such a thesis is hardly new. In 1888 Heinrich Wölfflin entitled his doctoral dissertation "Prolegomena to a Psychology of Architecture," and opened with the question "How is it possible that architectural forms are able to express an emotion or a mood?" He pointed out that we animate architectural events "*because we ourselves possess a body*"—that is, because the optic nerves stimulates the motor nerves and thereby sympathetically works on our own neural system through our bodily organization. Because we know the force of gravity through our own corporeal experience, for instance, we read the weight and balance of a building in gravitational terms. Wöllflin claims that we judge a work of architecture to be beautiful because it mirrors the "*basic conditions of organic life.*"[17]

The recognition of our embodied natures is particularly important in this age of parametric design, which can often lead the designer down the path of greater abstraction. Students may be fascinated with the new power to wield or manipulate forms endlessly on a computer screen, yet design is indeed a zero-sum game. The aspects on which one focuses one's effort during the design process largely determine what the final result will be. When one is enamored with formal exploration, one may well devote less attention to issues of scale, materiality, or detailing. When one focuses on the properties of form, one is bound to be less concerned with how the user actually experiences the elements or appraises the ambience of the design.

16 Robert Vischer, "On the Optical Sense of Form: A Contribution to Aesthetics," in H. F. Mallgrave and E. Ikonomou (eds.), *Empathy, Form, and Space* (Santa Monica: Getty Center Publication Programs, 1994).

17 Heinrich Wölfflin, "Prolegomena to a Psychology of Architecture," in Mallgrave and Ikonomou, *Empathy, Form, and Space* (note 16), 150-51, 160.

Whatever the advantages or limitations of software programs, they will never relieve the architect of the responsibility for creating an environment conducive to human vitality, nor should they prevent us from pursuing more deeply the core features of architectural design. Architecture is inherently a multisensory experience on multiple levels involving memories and a joy of play and anticipation, one that defies any deterministic or reductive prescriptions. The question of course is whether we have the tools of the cognitive understanding to do so presently—that is, understand how we really experience architecture?

Mirrors within Ourselves

With the discovery of mirror neurons in the early 1990s, an entirely new field opened for investigation.[18] Mirror neurons, or mirror systems, are groups of neurons that respond to perceptual experiences in a simulating fashion. If I see or hear you playing the piano, mirror systems in my premotor and parietal cortices mimic areas of your brain activity as if I were playing the piano. If I am an equally skilled pianist as you are, these mirror systems are quite similar to your brain maps—except for areas of the motor cortex that would actually move my hands and fingers. Such a process has since been named embodied simulation.

Over the last decade hundreds of neuroimaging studies of embodied simulation in humans have taken place, but two or three experiments in particular should be known to architects. In one experiment, investigators were monitoring the mirror systems of participants watching others being touched by people and objects. Surprisingly, they also found mirror activity when people observed two inanimate objects touching one another. In the concluding remarks of their paper, the researchers noted that "models of embodied simulation posit that the same neural structures involved in our own bodily-related experiences contribute to the conceptualization of what we observe in the world around us."[19]

Architecture, of course, consists of materials and objects touching one another. Our craft is based on composition and detailing. We have also learned that when we view materials, we activate circuits in our somatosensory cortex, as if we were

18 See Giacomo Rizzolatti and Corrado Sinigaglia, *Mirrors in the Brain* (Oxford: Oxford University Press, 2008).

19 Sjoerd J. H. Ebisch et al, "The Sense of Touch: Embodied Simulation in a Visuotactile Mirroring Mechanism for Observed Animate or Inanimate Touch," *Journal of Cognitive Neuroscience,* vol. 20, #9 (2008), 1621.

also touching the materials in an act of tactile understanding. All of this would suggest that when we experience a building in the flesh, we activate mirror (sensorimotor), emotional, and hedonic systems. In other words, in experiencing a building we emotionally simulate the forms, materials, and details with our bodies. When the perception gives us pleasure, our gray matter becomes flooded with chemicals announcing this fact to consciousness. Much of this activity is preconscious and emotional. We cannot in fact avoid emotion, however much we might try to do so. Emotions are the very lens through which we perceive the world.

A second study undertaken by Vittorio Gallese and the art historian David Freedberg carry this insight to another level. In reviewing a number of neuroimaging studies, the authors conclude not only are these "embodied mechanisms encompassing the simulation of actions, emotions and corporeal sensations" fundamental to our reading of artistic activity, but they also entail "the artist's creative gestures, such as vigorous modeling in clay or paint, fast brushwork and signs of the movement of the hands more generally."[20] In short, we simulate the energetic activity that went into the artistic creation. In viewing this Assyrian bas-relief, for example, we might read it reflectively as a narrative history of a proud warrior in victory, but in standing before it in the British Museum we experience it in an entirely different way. We study the delicate chisel marks that created it, we admire the intricacy and detail of the author's hand—all because we are simulating what it feels like to have our own hands chiseling the alabaster.

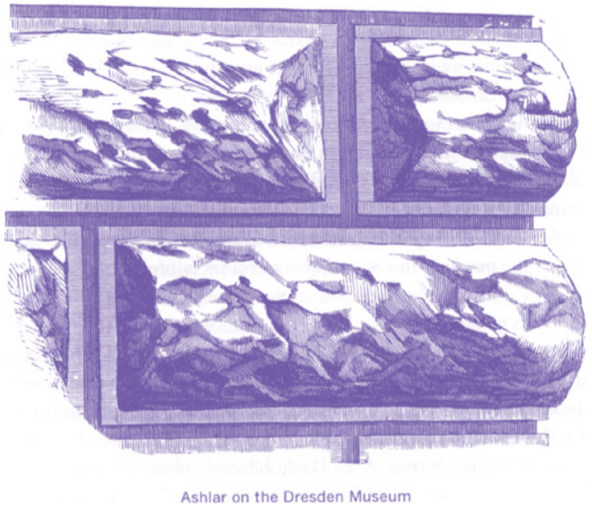
Humphrey Repton, Proposed landscape design at Wentworth, South Yorkshire.

20 David Freedberg and Vittorio Gallese, "Motion, Emotion and Empathy in Esthetic Experience," *Trends in Cognitive Science,* vol.11, #5 (2007), 199.

As it turns out this particular panel was of great fascination to Gottfried Semper, who studied it in London in 1850 shortly after his arrival in London. A few years later, in writing his book on *Style,* he often spoke of architecture in an animate way, presaging the research of Freedberg and Gallese. In describing the rusticated blocks of his Art Gallery in Dresden, for example, he notes how the cushion of each block bows outward to reflect the weight of the wall bearing down on it. He reports how the chisel blows must be directed toward the center of the block, so that its forces can be contained at the perimeter by the smooth band. In this way, he felt, the overall composition acquired a regular or eurythmic "beat," a musical rhythm produced from the tension-filled network of simulated forces.[21] When and why did architects cease to look at architecture in such vivid terms?

Assyrian panel from the Palace of Ashurnasirpal II, Nimrud (9th century BCE), British Museum, London. Photograph by author.

21 Gottfried Semper, *Style in the Technical and Tectonic Arts,* trans. Harry F. Mallgrave and Michael Robinson (Los Angeles, Getty Publications, 2004), 732.



Gottfried Semper, Ashlar treatment of the Dresden Art Gallery, from *Der Stil in den technischen und tektonischen Künsten* (II: 1863).

Let me close with one other point. For some years now Ellen Dissanayake has been tracking the origin of the arts—in evolutionary forms of play and in ritualistic and ceremonial behaviors, such as early human exercises in costume-making, music, and dance. In her more recent study *Art and Intimacy*, Dissanayake buffers her case by citing the work of Colwyn Trevarthen, whose research focused on how mothers and infants build loving bonds through universal modes of interactions: the cooing patterns of vocal intonation, rhythmic exaggerations, and visual and tactile give-and-takes.[22]

Dissanayake then goes on to offer the hypothesis "that these same sensitivities and capacities, which arose as instruments of survival in our remote hominin past, are later used and elaborated in the rhythms and modes of adult love and art."[23] This conflation of love and art might initially have seemed odd, but around the time she was proposing her hypothesis several neuroimaging studies demonstrated that love and art do share a similar hedonic circuit.[24]

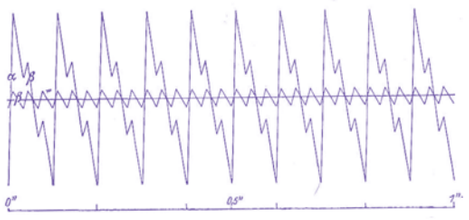
22 Ellen Dissanayake, *Art and Intimacy* (Seattle: University of Washington Press, 2000), 15-17.
23 Ibid., 6.
24 See, for instance, Semir Zeki and Andreas Bartels, "The Neural Basis of Romantic Love," *Neuroreport*, vol. 11, #17 (2000), 3829-34; Hideaki Kawabata and Semir Zeki, "Neural Correlates of Beauty," *Journal of Neurophysiology*, vol. 91 (2004),1699-1705; Semir Zeki and Andreas Bartels, "The Neural Correlates of Maternal and Romantic Love," *Neuroimage*, vol. 21 (2004), 1155-66.

Dissanayake took her case further, however, first by arguing that these "rhythms and modes" underlying artistic expression extend back into pre-Paleolithic stages of human evolution and are pre-symbolic in their biological underpinnings. Second, that these rhythms and modes are related to emotional drives associated with enculturation, and are manifested in such things as social affiliation, making sense of our surroundings, acquiring competence in skills, and what she refers to as "elaborating upon." All of these activities, when applied to architecture, seem to support her contention that the arts "emerged through human evolution as multi-media elaborations of rhythmic-modal capacities that by means of these elaborations gave emotional meaning and purpose to biologically vital activities."[25]

If we rarely refer to the experience of architecture today as "cross modal sensations of tactility and kinesis" (to use Dissanayake's expression), perhaps it is because we have for too long designed our habitats in overly conceptual terms And if we do so, it is perhaps because with all our learning we have forgotten that what we refer to as cultural changes are more simply "variations" on our ingrained bodily skills.[26] Perhaps our focus on representational values has concealed the fact that architectural design is, on a primal level, simply the play of materials, colors, forms, patterns, and textures, and that the task of the architect is to design an environment that is both pleasing, creative, and revelatory. The role of the biological sciences today is not to prescribe any formula for making these creations special—that is the hubris of yesteryear. What biology is revealing today is that we are highly complex creatures, sophisticated in our ideas yet at heart rather simple animals of pleasure. We respond to our built environment in many ways, but perhaps most importantly as cognitive animals in the flesh.

25 Ellen Dissanayake, *Art and Intimacy* (note 22), 145.
26 See Tim Ingold, "'People like us': The concept of the anatomically modern human" in *The Perception of the Environment* (London: Routledge, 2000), 373-91.

HANS BERGER AND THE E.E.G.
KRISTER HOLMES



Hans Berger's conception of the alpha and beta waves, fundamental brain frequencies upon which all successive EEG science was to develop

In a concerted effort to bridge the divide separating humans and their machines, Brain Computer Interfaces (BCIs) are becoming commercially available. These devices, based on the electroencephalogram (EEG), read electrical impulses from the brain and then translate those impulses into computer code. This new computer interface is critically polarizing in nature. For architecture, BCIs could represent a kind of endpoint. The Brain Computer Interface contains a space where mind and its instrument can short circuit language, the intellect, social interaction, and physical reality. The BCI is a radically open architecture of endless self-reflection free of the discomforts and annoyances of 'real' architectural space. In the end, the BCI reifies the gap it attempts to bridge.

Historical investigation shakes loose the simplicity of this facile dichotomy. If we examine the technological history of the instrument that is the darling of computer programmers, gamers, transhumanists, artificial intelligence researchers and even some cutting edge architects it is possible to break free of the paralyzing dialectic plaguing many fields. Hans Berger is widely regarded as the discoverer of the electroencephalogram. Through the process of this investigation it becomes clear that it is Berger's refusal to conform to the tenets of scientific rationalism, his technical and representational obsessions, and his magpie-like curation of multiple conflicting epistemologies are what allowed his discovery—and may even suggest strategies for the present. The history of the human electroencephalogram reveals there was never a gap for the brain computer interface to fill. The EEG is not historically contained within any dichotomy, and if anything, it bears out the fact that humans have always been both technical and natural—even that these categories no longer bear any relational meaning to one another. The invention of the EEG by this amateur researcher in the early years of the 19th century shows this imaginary opposition between that which is human and that which is technical obscures a more complex ontology.

The slow birth of the human electroencephalogram (EEG) in the 1920s represents a unique technical history. While still incredibly useful in some diagnostic capacities, the EEG has largely been supplanted by higher resolution and less abstract imaging devices. However, nothing today can compete with the EEGs temporal resolution. The nature of graphing the electrical potentials of the human brain poses questions about our understanding of electricity, consciousness, their representations.

Hans Berger (1873-1941) a doctor and amateur neurological investigator who lived and worked in Jena, Germany, is widely regarded as the discoverer of the human electroencephalogram. Berger's position outside conventional discourse networks allowed him to posit new modes of investigation. The research position he insinuated afforded him the opportunity to ask questions that other investigators were either intimidated by, or apathetic toward. Berger's new application of the graphical method, coupled with his unique epistemological positioning, served to disclose horizons within and between which contemporary projects proceed.

Hans Berger became interested in studying the nature of the brain because of a parapsychological event. While serving as a soldier during World War I, Berger fell from his horse and was nearly killed by a cannon cart. That same evening he received his first-ever telegram from his father, occasioned by his sister's extrasensory perception:

> *She had suddenly told my parents that she knew with certainty that I had suffered an accident... This is a case of spontaneous telepathy in which at a time of mortal danger... I transmitted my thoughts, while my sister, who was particularly close to me, acted as the receiver.*[1]

This inspiration, while probably not quite so alarming a generation earlier, clearly differentiated Berger from his contemporaries. This slightly anachronistic approach, combined with his personal conviction to trace the mental telegraphy able to elicit an electrical telegram, is what created the space for Berger to investigate the nature of electrical activity emanating from the

1 Hans Berger, *On The Encephalogram of Man* trans. Pierre Gloor (London: Elsevier, 1969), 3.

brain. According to Pierre Gloor, medical historian and translator of Berger's reports, Berger rejected the two prevailing discourse networks available to him: the neuroanatomists and the psychological functionalists. Where the neuroanatomists sought the physical trace and electrochemical nature of neural communication, the functionalists investigated the outward signs of subjective experience.[2] The neuroanatomists could not imagine being able to coax any meaningful pattern from the multitudes of electrical communiqués occurring every second, nor could they believe that the information could be read from the scalp.[3] The functionalists were simply confused as to what the question even was.

Prior to his fame as a neuroanatomist and cyberneticist, William Grey Walter worked for the acclaimed electrophysiologists E.D. Adrian and B.H.C. Matthews at Cambridge. In 1928 Hans Berger's reports were becoming more widely known and largely disparaged. That year Ivan Pavlov—a functionalist—came to visit Adrian and Matthews' school of electrophysiology. Walter reported that Pavlov "was not in the least interested in the mechanism of cerebral events; they just happened, and it was the happening and its consequences that interested him, not how they happened."[4] The electrophysiological workings of the directing organ were not within the purview of Pavlov's investigation.

While Berger's investigations were of no interest to Pavlov, they were also at odds with the other significant group of neural investigators: the neuroanatomists. Emil Du Bois-Reymond was a giant in electrophysiology and neuroanatomy and was so personally influential for Berger frequently that he frequently referenced him in aphorisms. Berger wrestled with du Bois-Reymond's maxim: "*ignoramus et ignorabimus*" (We do not know and we will not know). Du Bois-Reymond's phrase prompted Berger's defensive refrain through almost all of his reports in one fashion or another: "certainly we do not know these material processes, but in my opinion we have here in the α-w [alpha wave] a concomitant phenomenon of these processes."[5] It was not the material representation of consciousness that Berger

2 The psychophysiology promisingly initiated by Weber, Fechner, Helmholtz and Wundt had fallen into disrepute. Instead "two approaches had become fashionable, the neuroanatomical approach of... Meynert, Flechsig, and von Monakow, and the functional approach as exemplified by the work of... Janet, Freud, Adler and Jung." Berger, *On The Encephalogram of Man,* 3.

3 Berger, *On The Encephalogram of Man,* 10.

4 Walter, William Grey, *The Living Brain* (London: Gerald Duckworth & Co., 1953), 28.

5 Berger, *On The Encephalogram of Man,* 129.

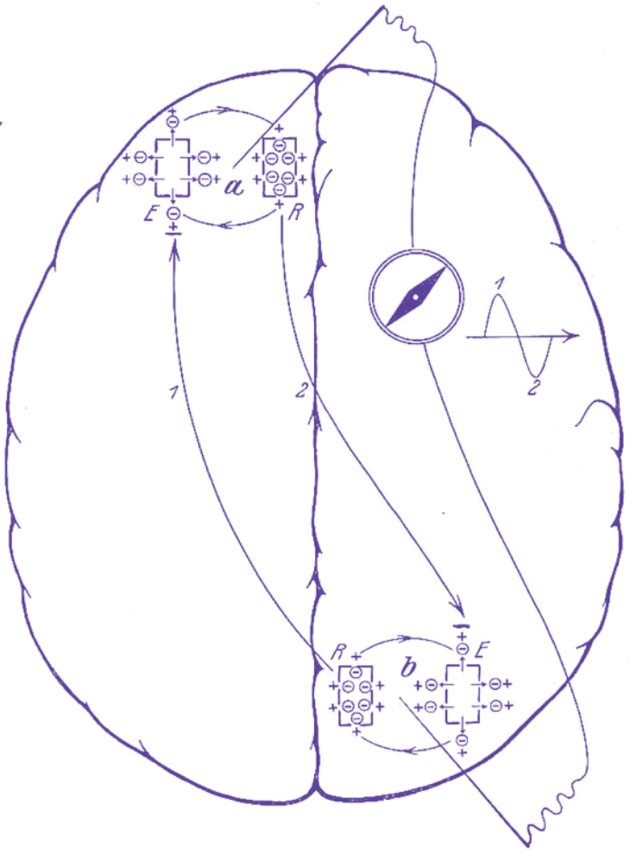


Diagram of electrical potentials within the brain. E: state of excitation, R: state of quiescence, a+b two recording points. Hans Berger 1931.

claimed to be measuring, but merely the traces left behind by a complex phenomenon as it registered in the electromagnetic band.

A coherent metrological representation capable of registering and charting something as vast as the human brain was inconceivable for du Bois-Reymond and the other neuroanatomists. Consequently, Berger relied on the arguments of Angelo Mosso, another brain researcher and predecessor working in brain plethsmography, to defend his own endeavor against the neuroanatomists' objections:

> *Mosso... stressed that each time we apply exact measuring instruments to the brain, the hope rightly stirs in us that we may learn to recognize the physical bases of consciousness. Even when we do not arrive at a satisfactory*

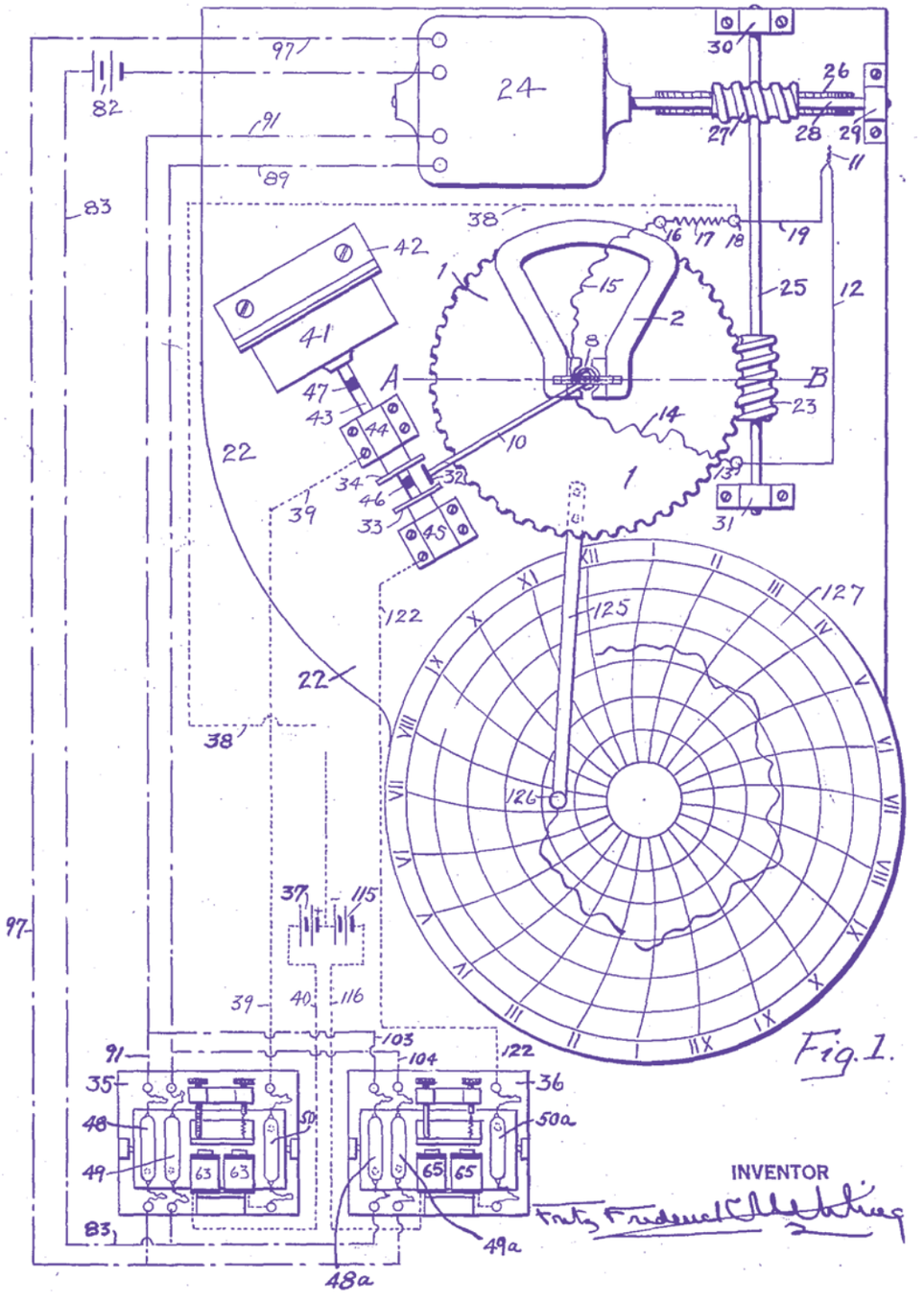
result, we could nevertheless be certain… that we are on the right path to discovery.[6]

For Berger, it was possible to incrementally breach the human interior via the coded voltage potentials emanating through the hard casement of the skull. Du Bois-Reymond would only venture so far as to allow that the electrical activity was there, but refused to connect it with anything more than the incomprehensibly complex web of biological wiring. Du Bois-Reymond would not have believed measuring such a phenomenon could produce a coherent representation. But to du Bois-Reymond's 'we do not know and we will not know,' Berger felt compelled to add, 'but we can observe the concomitant phenomena of mental events.'

Berger attempted to observe the traces of consciousness through the neuroanatomical graphical method. His telepathic experience drove him to constantly seek new technological innovations in an attempt to be able to measure at the speed of thought.[7] Berger rejected the method used in today's fMRI machines—hemodynamic response (although it had no such designation at the time)—as having insufficient temporal resolution. The only way to measure fast enough was to adapt existing equipment intended for the measurement of the electrocardiogram (itself derived from telegraph instrumentation whose temporal resolution was driven by the financial gains proffered by the efficiencies of speed). By co-opting the machines of the more developed and respected discipline of cardiology, Hans Berger leveraged existing representational methods to justify his own—just as famed physiologists Herman von Helmholtz and Etienne-Jules Marey used industrial measuring devices to leverage their self-registration instruments and representations.[8] While his contemporaries pursued one of two avenues, Berger synthesized a third. Utilizing the principles of electrophysiology he measured what the neuroanatomists surmised was a vast, chaotic emptiness and recorded consciousness as it was experiencing and reacting to phenomena. Surprisingly, the representation of this process resembled the sinusoidal curves being created by electricity generating alternators, and transatlantic telegraph signals.

To ensure objective representations of psychic events, experimental subjects were to be kept safe from external stimulation,[9] and Berger's machines required a stringent electro-

6 Ibid. [can use "Ibid" here (typ.)]
7 Ibid.
8 De Chadarevian, Soraya, "Graphical Method and Discipline: Self-Recording Instruments in Nineteenth-Century Physiology," *Studies in the History of the Philosophy of Science* 24 (1993): 284.
9 Berger, *On The Encephalogram of Man,* 136.



Recording Galvanometer. F.F. Uehling 1921.

magnetic context as well. Everything electrical, even in adjacent buildings, had to be turned off. Any wires in the specially prepared room had to be highly shielded to avoid environmental contamination of the reading. The room was almost ritually cleansed of electromagnetic radiation.[10] To capture the ideal representation, "it is certainly best… if the experimental subject lies in a half-darkened room with his eyes closed, leaves free rein to his thoughts and attempts to fall asleep."[11] The environment and subject were thus prepared for the brain's electrical activity to reveal itself by causing the shadow of a metal thread, suspended between two magnets, to burn a white line on a black roll of paper feeding silently into a box.

Berger also leveraged media theory to justify the results of his recordings:

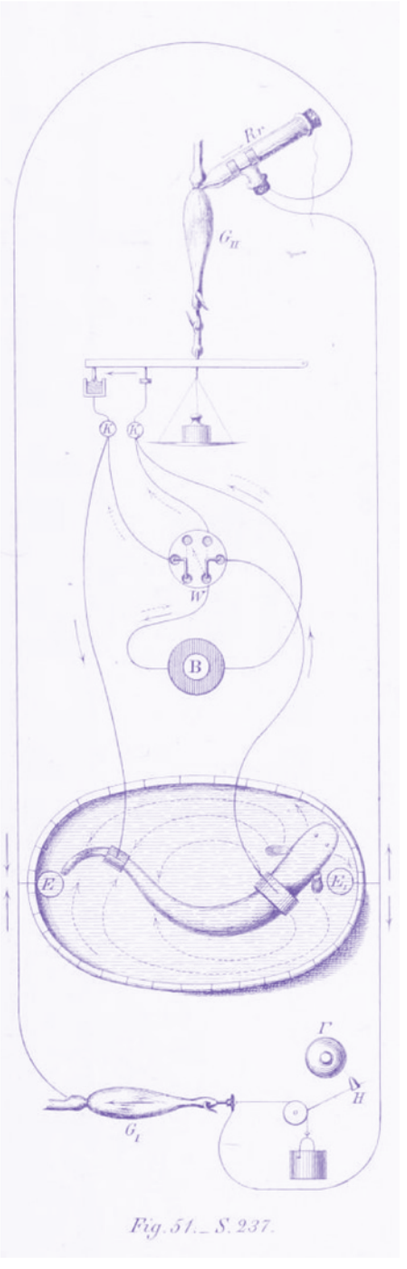
> *Alfred Lehmann… famous for his excellent research on concomitant phenomena of mental processes, expressed the opinion in his "Psychophysiology" that 15 images per second are sufficient to create the illusion of a steady movement in a cinematographic performance and that a greater number of images are disturbing… He therefore also regards the mental side as being composed of individual component parts, which coalesce into a uniform whole.*[12]

Lehmann's frame rate consciousness corresponded to the frequency range of the sinusoidal waves running along kilometers of

10 "During the recording of the EEG it is of course necessary to turn off X-ray and particularly diathermy instruments, even if they are located in buildings of the clinic which are separate from the examination room. Furthermore all electrical machinery, as is e.g. used for the laundry, also has to be switched off. Apart from that it became necessary to provide the lines supplying power for the electrical lights, etc. with extensive shielding devices against interference. During the actual recording the experimental subject and the recording apparatus are located in separate rooms and all electrical signals must be avoided and replaced by purely mechanical devices." Berger, *On The Encephalogram of Man,* 134.

11 Berger, *On The Encephalogram of Man,* 136.

12 Berger, *On The Encephalogram of Man,* 131.



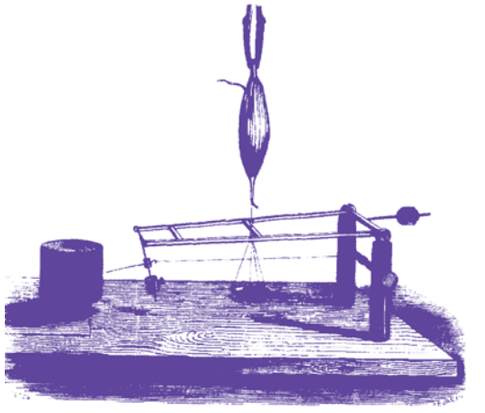
Emil Du Bois-Reymond's experiment using Helmholtz' frog tracing machine wired to a torpedo fish. Du Bois-Reymond's non-polarizeable electrodes used in this experiment made Hans Berger early experiments possible. Emil Du Bois-Reymond 1881.

bromide paper stored in Berger's clinic basement. While Berger disavowed any direct influence on his own work, he indemnified his observations through physiological theories of media and signalization.

Electrophysiology and communications advancements have a reciprocal representational history, which is mutually disciplining. Both pursuits provided the technical and representational means for the other's advancement, while surreptitiously passing on habits of order, and subordination, as well as technical and epistemological blind spots. The first recording galvanometers were based on Luigi Galvani's "frog leg nerve preparation," the standard of galvanometers for decades.[13] The instruments were appendages harvested from frogs. Kelvin's mirror galvanometer—intended for the reception of transatlantic communication—was influenced by Helmholtz' version of Galvani's frog leg physiology galvanometer. And Richard Caton, a very early brain researcher who observed electrochemical activity in the brains of cats, used Lord Kelvin's telegraph galvanometer to measure electrical potentials in the brains of animals.[14] Hans Berger opened up an entirely new mode of representation, intervention and discipline, built on the technical instrumentation of his predecessors and contemporaries. Images generated by equipment genealogically inseparable from transatlantic communication were now being utilized to naturalize and diagnose psychic processes. Berger collapsed multiple modes of scientific inquiry in an attempt to finally get hold

13 O'Leary, *Science and Epilepsy,* 67.

14 L.A. Geddes, "What did Caton See?(is there a question mark here??)," *Electroencephalography and Clinical Neurophysiology* 67 (1987): 2.

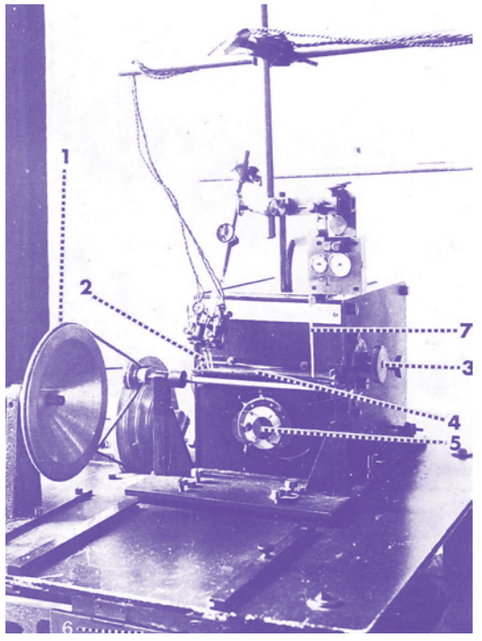


Herman von Helmholtz' frog tracing machine used to measure the propagation of electrical nerve impulses and later to test transatlantic telegraph systems. It consists of a prepared frog leg with an exposed nerve whose movement was traced by a pen. E-J Marey 1868.

Very early EEG recording attempt. Hans Berger 1920s

of his miraculous telepathic communication. Unsatisfied with conventional methods to represent at the speed of thought, sure of the electrical bases of these mental processes and bolstered by media theories, Berger relied on each epistemology to justify his observations in the others while remaining outside any single paradigm.

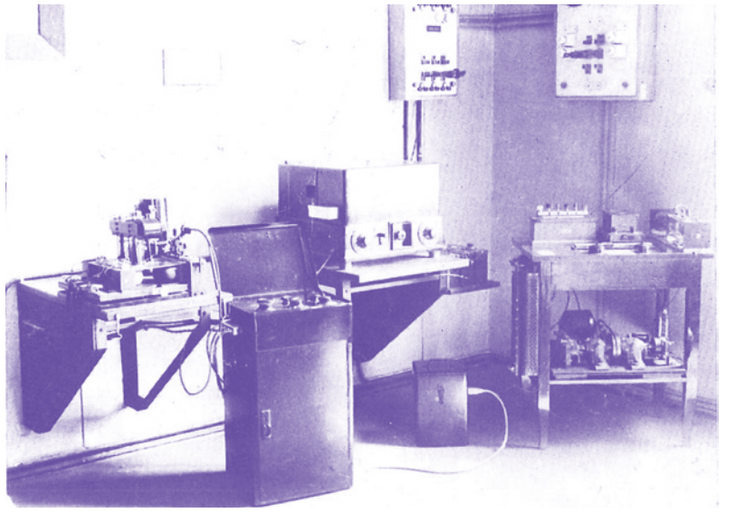
Significant observational boundaries and opportunities were inscribed by Berger's epistemological perspective. Berger took advantage of the graphical self-registration methodologies of his day. Present day projects marshal the power of new methods of graphing cognitive events in order to represent the effect of architecture on the brain, and medically demonstrate the effect of architecture on health and emotional well-being,[15] or even feed a representation of the brain's activity back to itself through responsive architecture.[16] How does contemporary statistical data modeling—with its coterie of normalizing distributions, new modes of abstraction, methods of representation—and



Hans Berger's original Edelmann String Galvanometer from 1910. Berger's technician W. Keuscher labelled the drawing: 1. crank driving the motor 2. straw fiber markers 3. recording paper feed switch 4. graduated lense 5. diaphragm and marker 6. exposed paper box 7. time marking tuning fork. Hans Berger, W. Keuscher 1910

15 Dr. Eve Edelstein MArch, PhD (Neruo), EDAC, AIA, is president of Innovative Design Science, a neuro architectural design firm focusing on neuroscience, healthcare, physiology, anthropology, design and architecture. An interview with her discussing neuroarchitectural applications in healthcare from an extremely interdisciplinary perspective sheds light on contemporary evidence-based design in: "Linda Hossie, "This is Your Brain on Architecture," *CrossCurrents – The Journal of Addiction and Mental Health* 15.1 (2011): 17.

16 Mattia Caslegno and Enzo Varriale at iMAL Centre for digital Cultures and Technology, Brussels are providing workshops to help integrate EEG with other media. Projects have included responsive architecture utilizing Grasshopper design software in conjunction with EEG registering device Emotiv (project by Elise Elsacker): http://www.grasshopper3d.com/video/eeg-and-biofeedback-architecture (accessed on 09/01/13). iMAL workshop: http://www.imal.org/en/activity/tangible-feelings(accessed on 09/01/13).



Hans Berger's EEG laboratory at the University of Jena. Hans Berger 1926-1931

the implied opportunities for intervention—reveal different horizons of investigation? As we make the decision to incorporate these new neuroimaging modalities into the discipline of architecture, it seems incumbent to grasp exactly what is represented in an fMRI depicting a colourfully glowing brain floating in a black field;[17] a brain somehow enraptured or improved by waves of architectural perception. It is apparent from our discussion of Hans Berger that there is a different type of validity implied by the instrumental, graphic representation of data extracted from inside the dark recesses of our skulls. How can we incorporate new scientific understanding within the considerably older and more nuanced practice of conventional architectural history and theory? Surely there must be a position between complete obsession and cynical dismissal; preconscious affect and complex intersubjectivity. Given the history of the EEG, it seems the most important question now might be: how are the three entangled concepts of electricity, perception and their representations disciplining one another now?

17 Barbara Stafford provides a fascinating discussion of the nature and influence of medical representation on artistic practices, as well as the implications of the aesthetic practices of contemporary medical imaging, in her book *Body Criticism*. See: Barbara Stafford, *Body Criticism: Imaging the Unseen in Enlightenment Art and Medicine* (Cambridge, MA: MIT Press, 1991).

section four

medicine

NORMAL AND PATHOLOGICAL HUMANITY MICHAEL HAGNER ON CANGUILHEM, *INTERVIEWED BY CAROLINE A. JONES*

Caroline A. Jones: *Georges Canguilhem is known to most English-speakers today through the 1991 Zone translation of The Normal and the Pathological, which was published with an important introduction by Michel Foucault that secured its rapid uptake here. Can you speak broadly to the importance you ascribe to the later work of Canguilhem, which is not as well known?*

Michael Hagner: The Zone edition made Canguilhem's book famous, but the English translation of *The Normal and the Pathological* was in fact first published in 1978, already with Foucault's introduction. In that very influential text, Foucault argued that Canguilhem developed a philosophy of error, of concept, and of life against a philosophy of sense, of subjects, and of experience. The latter one was represented by phenomenology and existentialism, mainly through Sartre and Merleau-Ponty; the former one was the rationalistic tradition of Bachelard and Canguilhem, into which Foucault integrated himself. What I find striking – and what motivated me to write an afterword to his later essays[1] – is that Canguilhem published most of these essays on medicine after 1978, after Foucault's introduction. In these texts Canguilhem did not quite turn into an existentialist, but – perhaps feeling plagued by his own age, (he was born in 1904) – he reflected about basic questions of medicine, such as health, cure, the concept of nature in medical theory and practice, the power and the limitations of rationality in medicine – and, of course, the human. These essays use examples from history, but in these texts Canguilhem's perspective is that of a philosopher of medicine. This is a dimension in his œuvre leading beyond his epistemological and his historical interests. Whereas in *The Normal and the Pathological* Canguilhem argued that organisms, in the status of health as well as in that of disease, set their own norms according to the principle of auto-correction, in his late essays he is reflecting about the human subject that experiences its own precarious status in contemplation of death.

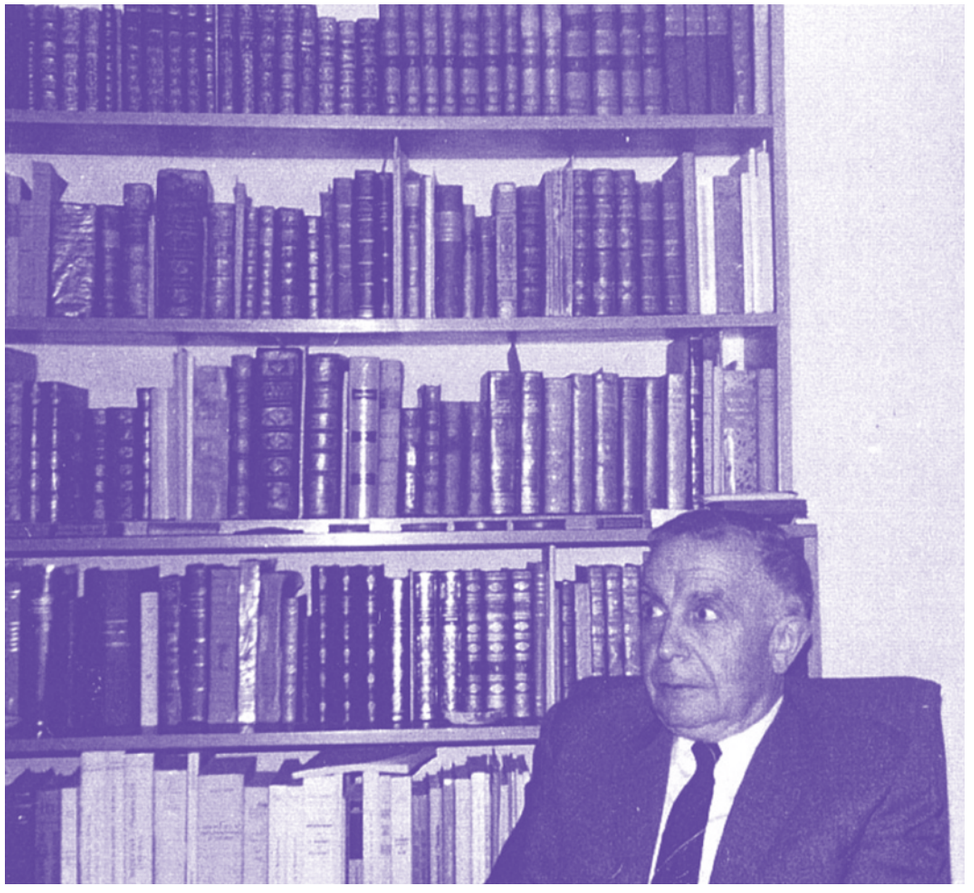
1 See Michael Hagner, Georges Canguilhem und das Problem der Medizin, in: Georges Canguilhem, Schriften zur Medizin, tr. by Th. Laugstien. Zürich/Berlin: diaphanes 2013, pp. 115-143. Canguilhem's essays have also recently been translated into English: Georges Canguilhem, Writings on medicine, tr. and with an introduction by Stefanos Geroulanos and Todd Meyers. Fordham University Press 2012.

CAJ: *You comment that Canguilhem's work can be seen, on the one hand, as a simple history of medicine; yet you also point out his broader concern with the foundations of all organic life. Would Foucault have too narrow a view of Canguilhem as uniquely concerned with the human? With understanding how the normativity of "health" is regulated in the human? Or, as you explore in your introduction to the German publication of these texts, is Canguilhem more engaged with organisms or beings more generally?*

MH: In his introduction, Foucault is primarily concerned with Canguilhem's historical epistemology. He emphasizes Canguilhem's insight that it would have been impossible to constitute the *sciences de la vie* by the end of the 18th century without taking into consideration disease, monstrosity, anomaly, or death. Therefore, medicine is a most important field for the epistemology of the life sciences, yet Foucault would not argue that Canguilhem is mainly concerned with the human. Canguilhem is neither a phenomenologist nor does he develop an anthropocentric philosophy. For him, any human activity, be it sane or insane, is ultimately an expression of the specificity of the organism. In his epistemological writings, Canguilhem wanted to understand the ways in which this organismic specificity is conceived in the historical development of science and medicine. In his late writings, he pushed back his epistemology and explored how the organism can be seen to cope with its own imperfections. It seems to me that this turn leads to a paradox. On the one hand, Canguilhem shrinks back from the idea of an exceptional position for *homo sapiens*; on the other hand, he claims that humans are arguably the only species that observes and comments on its own physical decline.

CAJ: *Can you speak to the significance of Canguilhem's completing his doctorate with The Normal and the Pathological during World War 2 (it's published in 1943)? You discuss his politics as partly a function of disillusionment with the ineffectuality of the Resistance under Vichy. What about the corruption of medicine as a Hippocratic practice during the Reich, would this have been something he was aware of?*

MH: I do not know under which conditions Canguilhem defended his medical thesis in 1943, but the question, which traces were left in his writings by the occupation of France through Nazi Germany and the Vichy Regime, and by his engagement in the Résistance and the assassination of his friend Jean Cavaillés through the Nazis, is a matter of particular interest for me. This is because, in very general terms, I would say that the history of 20th century epistemology and Science Studies can only be understood as a product of its face-to-face confrontation with political totalitarianisms in those days. As far as I know, Canguilhem did not directly thematize the unique barbarism of medicine and biopolitics in Germany, but his experience under Vichy and the Nazi



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http://www.coin-philo.net/p_canguilhem.php

occupation certainly had consequences for his thinking. We can clearly see it, for example in his haunting warning against equating society and organism. He agreed with US physiologist Walter Cannon that there is a wisdom of the body, but he rejected the idea that there is something like a wisdom of society. This position was certainly a consequence of his experiences in the age of extremes and, as I should like to add, contrasts with current flirtations with the "wisdom of the crowd," for example.

CAJ: *In your text accompanying the German translation of these writings, you comment specifically on the developments of eugenics and cybernetics in confrontation with what it means to be human in the 20th century – this is how that warning against an "organismic society" takes shape, yes?*

MH: In my own work on the history of twentieth century brain research I argued a couple of years ago that one explanation for the success of the cybernetic paradigm after 1945 was that its machine-centered universalism was seen as a welcome remedy against the organism-centered stigmatizing typology of eugenics.[2] Hence, I was quite relieved, when I learned that Canguilhem rejected any analogy between the organism and society. In his speech to the French organization of the *Alliance israélite universelle*, in 1955, Canguilhem was fully aware of the political background that would be supplied for any discussion of "the issue of regulation in the organism and society," yet he did not mention eugenics explicitly. This silence may come as a surprise, but I would argue that it is merely the discretion of the epistemologist, who works with conceptual clarification rather than with particular reference to historical acts of terrorism and barbarism in order to reject that equation of organism and society. In the organism all elements exist for the good of the whole, but there's nothing like this self-regulating system in society. The living individual is characterized by self-regulation and homeostasis, society is not. Society, invented as a tool for the welfare of human beings, is in a notoriously endangered state, the organism is not, unless it is afflicted by sickness.

CAJ: *You identify the relationship between "Self-regulation" and "precarity" in the later Canguilhem. You often use the phrase "Auto-correct"... you must be conscious of its computerized analogy? What is the role of mechanism in Canguilhem's theory (and your own)?*

MH: True, for Canguilhem, the concepts of auto-correction and self-regulation are the most important mechanisms for the living being. He took these concepts from the German neurologist Kurt Goldstein, who characterized health and disease as two modes of relationship between an organism and its environment. He also adopted Walter Cannon's theory of homeostasis. Despite all their differences, these two theories (of auto-correction and homeostasis) can be seen as versions of systems theory, which have some striking similarities with cybernetics – though the latter has its reference point in self-regulating machines and computing devices, whereas the former has its reference point in the biological organism. Canguilhem was certainly interested in cybernetics, yet in his seminal 1947 lecture and paper on "Machine and organism" he argued that organisms should serve as models for building machines, and not vice versa.[3] This was against the mainstream at the time, and I am quite sympathetic with this view, because it prevents us from technological determinism and the odd idea of conceiving society as a cybernetic feedback mechanism.

CAJ: *What happens, when sickness comes into play?*

MH: Sickness disturbs the functional equilibrium between the organism and its respective environment. The organism is pushed to reset itself on a reduced functional level. Instead of abundant self-realization simple existence be-

2 See Michael Hagner, "Bilder der Kybernetik: Diagramm und Anthropologie, Schaltung und Nervensystem", in: idem, *Der Geist bei der Arbeit. Historische Untersuchungen zur Hirnforschung* (Göttingen: Wallstein, 2006): 195-222.

3 Georges Canguilhem, "Machine and Organism" (1947), translated from the French by Mark Cohen and Randall Cherry in Jonathan Crary and Sanford Kwinter, eds., *Incorporations* (New York: Zone Books, 1992): 44-69.

comes the new standard. But even in this reduced state, auto-correction functions; it operates as the organism tries to establish a new equilibrium, attempting to restore adequacy at a lower level. There will either be recovery or what Canguilhem calls "the emergence of a new order of life." Disease marks the dynamic field between precarity and auto-correction – neither fully one nor the other. This liminal state prevails until the ultimate precarity, which is death, about which Canguilhem has almost nothing to say until a specific moment in the very late texts.

CAJ: *Would this drive to equilibrium (even in the face of death) be characteristic of all life? Or does the human capacity for higher consciousness render it exceptional?*

MH: In this respect, humans are not exceptional. Living things identify, evaluate, set norms, figure their environment – it is the same with men and animals, even if monkeys have developed no medicine. This is a kind of philosophical anthropology in which the critique of anthropocentrism is clear: there's not such a big difference between the human and other. As Canguilhem puts it, humans "do not inhabit a higher level of reality than the milieu of the woodlouse or the gray mouse…".

CAJ: *In the 1940s, of course, Canguilhem was writing before the revolutions in molecular biology that transformed medicine after the 1960s, and even in the later writings he resists some of the implications of those new domains.*

MH: I think it is useful to distinguish between his writings from the 1940s, in which he was relying on systems theory of disease, and his late essays, in which he was concerned with other issues. In fact, he did not engage in detail with new developments in molecular biology, immunology, organ transplants, etc., and some commentators have blamed him for this lacuna. They see Canguilhem's late essays as cowing to certain fashionable arguments against the mechanization of medicine at the time. Indeed, he bemoaned the increasing replacement of doctors' clinical knowledge of the body with computer readouts. In an age when medicine itself had moved away from the organism (and became in a sense less reliant on "humans" for its practices), Canguilhem rarely failed to take a swipe at such a situation in the later texts. But at the same time he categorically refused to join in the critiques of medicine at the time.

CAJ: *What kinds of critiques were these?*

MH: Well, radical authors such as Ivan Illich made searing critiques of medicine in the 1970s, and advocated returning health practices to the hands of the people – essentially alternative or folk healing.[4] Canguilhem felt this was premature, that the psychosomatic actually explains very little about the way organisms heal themselves.

CAJ: *Is this because he is thinking about more than the human? His wider view of the organism gives him a much more robust faith in autopoeisis and the self-correcting mechanism. It's somewhat absurd to talk about psychosoma in the woodlouse – although we certainly use the grey mouse to study anxiety's deleterious effects!*

4 See Ivan Illich, Medical Nemesis. London 1974.

MH: The non-human powerfully balances his theories of the human organism. Canguilhem reminds us of the Hippocratic self-regulating body, but hints to a major difference. Self-regulation in the late 20th Century may no longer have the same meaning as in the times of ancient medicine, because the norms and value orientations have shifted. This is where the radicality of the original doctoral thesis, *The Normal and the Pathological*, returns. There is an *historical* framing of the human and its autocorrecting functions—the concept of health functions to set standards, and as such it thus depends on the context in which it is defined and structured. The capacity for some kind of health lies in the organic system, but the particular design of what that health *is*, cannot be separated from the concrete historical situation. Accordingly, the auto-corrective forces of the organism have to be seen in relation to the diagnostic tools and therapeutic power of medicine in a given historical context. For example, it does not matter if psychosomatic medicine can explain the nature of a given disease – what matters is whether anything psychosomatic can be an effective *practice.*

CAJ: *Neither can health and disease be separated from a much more personal situation, if I read you correctly. As you point out, for Canguilhem, in the end, death comes into view.*

MH: Right, this is the moment when the singularity of man comes into play. Since overly instrumentalized medicine *and* psychosomatic medicine *and* naturopathy challenge Canguilhem to criticism, then what's left? Here we recall that he is a philosopher asking basic questions about human existence. To put it in his own words: "The existence of disease as a general biological fact, and in particular an existential test in humans, raises the not yet convincingly answered question about the precariousness of organic structures".[5] This "precariousness" is crucial to the late writing. It is when Canguilhem addresses not just the pathological but *disease* in all of its voracity that he brings in Freud with his concept of the death drive as inherent to the biological organism. (Now scientists have identified this "programmatic drive" even at the chromosomal level, in the dwindling telomeres.) There is a wonderful passage in an essay that is not included in the "Writings on medicine". In this text, Canguilhem cites Freud on the death drive – but it is not a citation to Freud's famous papers or lectures but to a personal letter that the psychoanalyst wrote about his own aging.[6] In this personal musing, the elderly Freud (who would die of a ravaging mouth cancer) longs to no longer need to hold things together, but to let them drift to the inorganic. It is no coincidence that

5 Georges Canguilhem. *Writings on Medicine.* New York: Fordham University Press, 2012. http://muse.jhu.edu/ (accessed December 30, 2013), 41.

6 Georges Canguilhem, „Macht und Grenzen der medizinischen Rationalität", in: idem, Grenzen medizinischer Rationalität (Tübingen, edition diskord, 1989), 67. Canguilhem refers to Freud's letter to the Swiss clergyman and psychoanalyst Oskar Pfister from 11 October 1925.

this kind of thinking appeals to Canguilhem, who is himself experiencing dwindling forces. Now, the finiteness of life is the point: "Death is in life, disease is his character".[7]

CAJ: *Again, given our interests in this issue -- is this specific to the human?*

MH: Largely. My reading of Canguilhem is that he sees man as the smart animal that perceives and interprets the decline of his powers and looks death in the eye. Freud comes in here as arguing for the authenticity of illness and disease in the dissolution of organismic identity. All that leads to our resigned acceptance of death. We are dealing here with a massive shift of perspective for Canguilhem: for the human, life is a life unto death. Health is never complete and permanent, and the way to its end is inevitable.

CAJ: *That is a remarkable development for the theorist of the normal and the pathological. These would be considered binaries in the early work – mutually constitutive opposites that determine each other in a clinical system. Yet it appears that in these later works they merge with one another as the inevitable function of life: to eventually twine into disease and death.*

MH: This surprising turn to Freud in the late works can be seen as a disillusioned diagnostician who takes up another old doctor as a mouthpiece for his own position, bringing together concepts and experience, illness and fatigue, decay and death, to be adequately reflected. The fact that Canguilhem puts the experience of our own perishability into the center of his late essays does not mean that he returns to anthropocentrism. Canguilhem is of no use to phenomenology, in this respect Foucault is perfectly right. Yet he was not so much aware of the convergence of epistemology and (patho) Anthropology in Canguilhem's late essays, which wanted to come to terms with our own expiration.

CAJ: *Does that expiration remove the human from the animal, by virtue of that very consciousness of one's drive to die? The yearning to "drift to the organic" or a merging of energies with entropy?*

MH: The inevitability of death is constitutive for all living beings, but we are arguably the only ones who understand and try to overcome that entropy. The cyborg fantasy (that is, the immortality of machines or substitute organs)…

CAJ: *…or, in our age, the related (if bizarre) dream of becoming immortal through a data-upload or "Singularity"*[8]

MH: These would offer no escape for Canguilhem. Quoting F. Scott Fitzgerald, he conceives of our knowledge of death's inevitability as like holding two incompatible ideas in mind and continuing to function: "You should be able to recognize, for example, that all is hopeless and yet be determined to do something about it."[9]

CAJ: *Can there be a contemporary Canguilhem in philosophy of science? Is it precisely the humanist, mortal theorist of these late writings that we should be reading?*

MH: Some commentators have uttered disrespect for Canguilhem's late essays by emphasizing two criticisms. First, as we've discussed he did not carefully consider recent scientific developments such as the molecularization of medicine; and second, he explicitly rejected certain aspects of modern medicine. Indeed, Canguilhem – like the philosopher Hans Jonas – did not accept the criteria of brain death, and in one of his last texts, he was horrified by the perspective that the experience and judgment of the doctor were more and more replaced by a computer-generated diagnosis. Canguilhem did not directly refer to the monoculture of computational "evidence-based medicine," but it is remarkable that a contemporary commentator such as Richard Horton, the editor of *Lancet*, again and again refers to Canguilhem in his rejection of this polemical force against clinical practice.[10] Even if we may smile about such an old-fashioned European humanist position, I would argue that neither the connection between local experience and statistical probability, nor the question of the relationship between the doctor and the patient is solved in our age of bio-techological medicine. And given all those discussions on cyborgs and posthumanism, I find it healthy when Canguilhem reminds us that we are those smart animals in a remote corner of the cosmos who have not only invented gnosis – as Nietzsche put it–,[11] but who also have to realize our own death. It was quite illuminating for me to dig into these later publications, where we can see Canguilhem sitting side-by-side with Freud and his idea of *thanatos*. These are expansions to the brilliant insights about the normal and the pathological that make Canguilhem's late writings on medicine crucial reading for theorists (and practitioners) of the human.

7 See footnote 5.

8 Ray Kurzweil, *The Singularity is Near: When Humans Transcend Biology,* (New York: Penguin, 2005), argues that ultra-intelligent machines will allow humans to overcome the limits of biology through mechanisms that are mystical as much as technical – so far.

9 This quote is on the last page of the essay "Is there a pedagogy of healing?." Canguilhem quotes from F. Scott Fitzgerald's late short-story "The crack-up." Georges Canguilhem. *Writings on Medicine.* New York: Fordham University Press, 2012. http://muse.jhu.edu/ (accessed December 30, 2013), 66.

10 See e. g. Richard Horton's review of the recently published translation into English of some of these same late essays (note 1), Canguilhem's *Writings on Medicine* in *Lancet* 380, September 8, 2012, p. 872; as well as his earlier essays on such as idem, "Georges Canguilhem, philosopher of disease," *Journal of the Royal Society of Medicine* 88, 1995, p. 316-319, and idem, "Rediscovering human dignity," *Lancet* 364, September 18, 2004, 1081-1085.

11 Friedrich Nietzsche, Über Wahrheit und Lüge im aussermoralischen Sinn, in: idem, Sämtlich Werke, vol. 1, Munich, Deutscher Taschenbuch Verlag 1980, pp. 875-890.

TREATING THE BODY: ARCHITECTURE AND BIOMEDICINE

SOFIA LEMOS & NICK AXEL

Ildefons Cerdà, *Map of the neighborhoods of the city of Barcelona and project for its improvements and enlargement*, 1859.

The ways in which architecture has historically conceived and formulated its potential for value within the modern city uncannily parallels the advances of medicine as a means of treating the body. The relation between the discipline of medicine with architectural practice emerged largely in response to the urban effects of the Industrial Revolution, ranging anywhere from environmental effects to demographic control. Ideologically distinct from capital-based projects such as the *Commissioners' Plan of 1811* for the island of Manhattan or identity-based projects such as the 1791 *L'Enfant Plan* for Washington D.C., the medicalization of the architectural project was most infamously canonized in Barcelona's 1859 *Plan Cerdá*, in which ideals of individual and public health served both as the impetus for development and the cornerstone of its design. Under the hygenic pretenses that the cause of such social ailments was at least in part the specific characteristics and attributes of the city itself, architecture was considered an experimental form of medicine in which societies' afflictions could be treated through the transformation of the built environment.

In "[the] end of the nineteenth century, when certain laboratory products (or processes) became commodities"[1] the discipline of medicinal treatment began to evolve from a chemical to an informational paradigm, effectively ushering a biopolitical economy through the employment of communications technologies. Catalyzed by the technological reformulation of the constitutive notion of the human body in its material ecology, the abstraction and synthesis between information and the body became the principal agent of progress in medicine for which living cells and genetic material were of paramount importance. Following World War II, the human body was recognized and treated as a complex cybernetic system of electric fields, fluids and biomechanics. The emergence of bioinformatics is seen as a paradigmatic shift in the practice of medicine as it places emphasis on highly technical forms of knowledge and the globalized commodification of health systems. Bioinformatics, increasingly essential to genetic research, reconfigures the material body by rendering it as data: the sequencing of genetic data pervades the body by establishing a fundamental equivalency between genetic code and computer code, and consequently, between biology and informatics.

Processes such as the shotgun sequencing method, first utilized in 1979, were able to determine the complete DNA sequence of a genome using software, thus demonstrating the abstract equivalency between informatics and biology. Computer software is used in order to assemble several random overlapping readings of DNA segments into one continuous sequence. This pairing of linguistic codes enables the theoretical interchangeability of materials and functions from one to the other: biological data can be reframed as informational data for both medicinal and non-medicinal purposes. The body is then both as much a medium in its means of communication, as it is mediated as the object of communication in a dialectical relationship where the biological data (genetic code) is intelligible by software, facilitating novel techniques of treatment, optimization and control of the organic body.

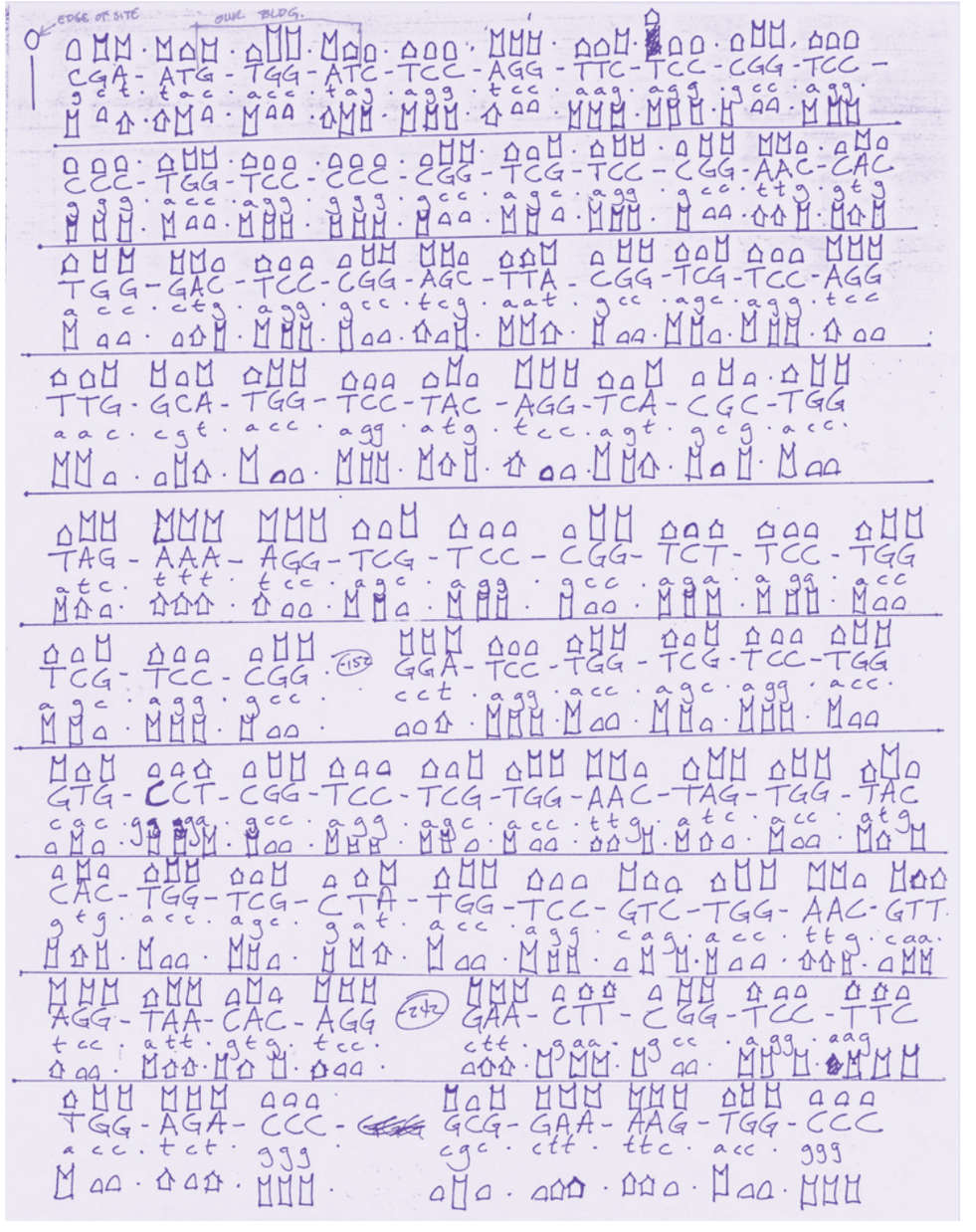
In the waning light of the modernist project and the advent of late-capitalist production systems, architecture and its late avant-garde found itself in the uncomfortable position of needing to justify the reasons for its own contingent existence. Alongside the projects of capital and identity as mentioned above, both of which prominently resurfaced during this pe-

1 Historian of science John Pickstone locates techno-medicine as the prevalent form of medicine practice in the second half of the twentieth century. See John Pickstone, Ways of Knowing: towards a historical sociology of science, technology and medicine (Cambridge: Cambridge University Press, 1993), 434

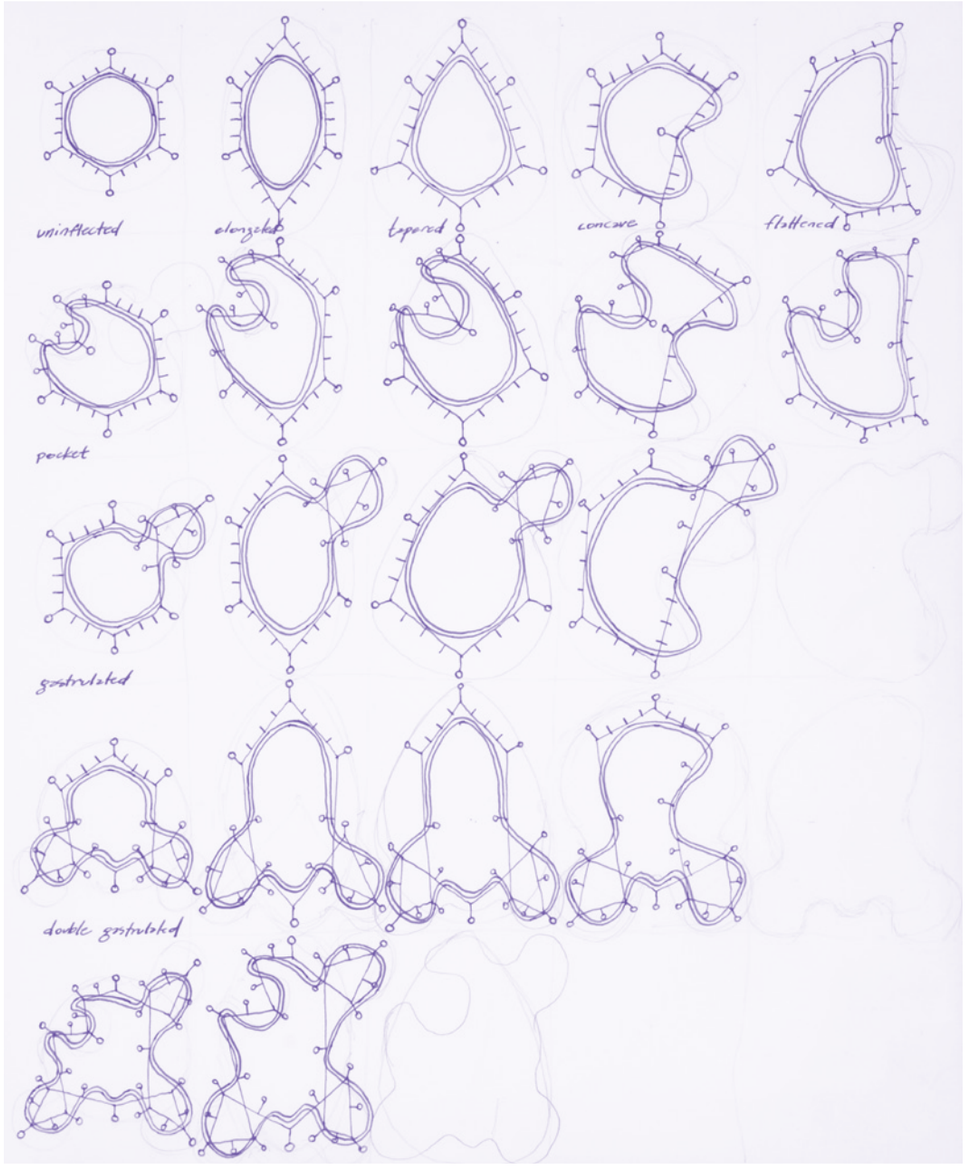
riod as well, the newly produced wealth of information about the biological nature of the human body was employed by the architectural discipline as a means to ground its claims of social value. In his unrealized 1987 project *Biozentrum* in Frankfurt, Peter Eisenman employed the morphological nature of DNA to diagrammatically impregnate his design with abstract representational traces of the 'human.' This humanistic imbrication of architectural space not only rationalized its radical formal design but also rhetorically legitimated the existence of the project itself by establishing a latent connection between architecture and a purported human essence.

This scientific representation of the body as a diagram culminated in the advent of the Human Genome Project (HGP), which ultimately sought to produce standardized genetic arrays, against which individual variations can be compared to and defined. The increased governmental investment in research into this technological pairing throughout the nineties signaled a deviation in the medical distribution of attention. Previously given to individuals, this consideration was then directed towards genes and molecules under the scientific discourse of genomics, the field of genetics that uses bioinformatics to sequence, analyze and assemble genomes. More complex database systems and better optical tools abstracted and expropriated the body from its subjective state to allow for a more accurate chemical method to create new custom tailored products, fostering an ever-growing commodification of health systems which render the body more pliant and subject to treatment.

Upon mapping the first complete working draft of the human genome in the first years of the two thousands, Greg Lynn's *Embryonic House* project from the same generation contains a remarkable affinity to the intentions of the HGP. Whereas the latter relates people's evident singularity to the common genetic alphabet shared among all human bodies, the former rhetorically compares the relation between each resident's individual identity to a generic methods in which houses are built. Predicated on technologically and economically feasible means of manufacture, a universally customizable "primitive" geometry was developed that would produce a definitively unique form for each client. In an extremely similar fashion to his mentor Eisenman, by translating the facticity of biological information into architectural terms Lynn sought to positively identify the house's inhabitant with the form of the house itself, through which an authentic and purportedly legitimate relation between architecture and its user would be established.



Peter Eisenman, *Biozentrum*, 1987. Montreal, The Canadian Centre for Architecture. Credit: Peter Eisenman fonds, Collection Centre Canadien d'Architecture / Canadian Centre for Architecture, Montréal



Greg Lynn FORM, *Embryological House*, 1997-2001. Montreal, The Canadian Centre for Architecture. Credit: Embryological House fonds, Collection Centre Canadien d'Architecture / Canadian Centre for Architecture, Montréal

As the mapping of the human genome became more economically feasible, other intersections between biology and bioinformatics such as regenerative medicine and bioartificial transplantation became cardinal fields of research within techno-sciences in the early years of the 21st century. Engendered by a discovery in 1998 that allowed for the production of immortalized cell lines, an abundance of research material favored the medical community to take greater risks in experimental development. Based on scientific breakthroughs of molecular biology, these lines of investigation aim to reconstitute the organic body by replacing, repairing, maintaining or improving tissue function. The potential for a high success rate in medicinal treatment such as in bio-artificial tissue 3D printing is predicated on research into histocompatability.[2] Inasmuch as tailored medical treatment is viewed as one of the great advancements in contemporary medicine, large funds have been directed towards investigating the potentialities of regenerative medicine, namely one of its larger fields stem cell therapy, in which researchers have learned to instruct cells how and where to differentiate into a particular cellular type as an immunological facsimile of the patients' body.

The 2004 social housing project *Quinta Monroy* by Elemental strongly embodies this contemporary form of medicinal treatment, as if literally representing the pluripotency of stem cells. While conceptually appearing similar to Lynn's *Embryonic House* in its integration of customization processes into a generic form, the differences between the two must be emphasized. By capitalizing and depending on the local tendencies of self-construction and dismissing the role of the architect as the deliverer of finished goods, *Quinta Monroy* largely rejects the transcendentality of design. In both projects, architecture is conceived as the medium through which an authentic relation between the house and its inhabitant can be formed. While Lynn's project demands the client to know exactly what it is they desire from architecture and the design of their residence, Elemental's project posits architecture itself as the discovery of spatial desire and its realization. What is therefore of tantamount importance is not that the inhabitant lives in a space that they identify with,

2 Originally associated with developments in graft transplantation and blood transfusion, histocompatability is where an exact copy of the patients' immunological system is sought so that the treatment will be effectively assimilated into the patient's body and not rejected as foreign. In the case of bio-artificial tissue printing, a high-resolution digital model of the organ to be replaced is created so that a mold of its form can be injected with high-density gel and let to nourish in an *in vivo* culture of the patients own cellular material before it is implanted, thus drastically reducing the possibility of rejection.

but that the inhabitant lives in a space, which they can then contrive if, when, and how they want.

The allure of stem cell therapy to pave the way towards the replenishment of damaged tissue has been expedited by recent research into the perfecting of miniature biomechanical devices that enable the stem cells to rapidly react to the local microenvironments and subsequently differentiate into a particular cell type once already inside the body's circulatory system. With the advent of nanotechnology, techniques such nanopatterning aid in controlling the differentiation state of stem cells and progress regenerative medicine to the most accurate atomic detail, fundamentally denaturing the epistemological framework for the human body and its somatic architecture. It is only through this type of rehabilitation and regeneration of organic matter that we explicitly confront the problematic notions of identity and origin(ality) of the human that have been progressively compromised throughout the historical development of modern medicine. How can we conceive of the carbon-based human life

ELEMENTAL, *Quinta Monroy*, 2004. (Photograph by Cristobal Palma. http://www.elementalchile.cl/proyecto/quinta-monroy/)

with(out) contemplating its synthetic companions? The present and future use of nanotechnologies undermines the distinction between the self and non-self by actualizing "the hyperreal collapse of humanistic discourse"[3] which agitates the extant and *a priori* stable rendering of identity. [1] This is perhaps most evident in nanomedicine, as it is defined by Robert Freitas "as the comprehensive monitoring, control, construction, repair, defense, and improvement of all human biological systems, working from the molecular level, using engineered nanodevices and nanostructures." [2] It becomes evident that nanotechnology as a new scientific discipline performs a paradoxical stand in the history of the life-science: as part of the apparatus of biotechnology it can be read in light of Luciana Parisi's assertion "The more it promises the absolute regeneration of *bios,* the more it exposes the autonomy of the inorganic from the organism."[4]

On one hand, biotechnology can be argued to possess the potential to *queer* biomedicine:[5] tissues, hormones and chromosomes can ideally be reformulated undermining any enlightened conceptions of a stable identity and presence by manufacturing an infinitely pliable body. On the other hand, the emphasis given to nanotechnology as a new type of industrialism further proves the shift from the chemical to the technological paradigm. In doing so, contemporary medicine abstracts bodily components to treat them as isolated somatic data so that organs, tissue and fluids can each occupy distinct hierarchical functions in a highly commodified health-care system. While it is in the historical intertwining of scientific discourse and policy making that the paradigm of corporeal treatment and ontological categorization of the 'human' was subsumed and deployed by architecture, the contemporary processes of large-scale mechanization that question the identity of the modern architect and threaten to further

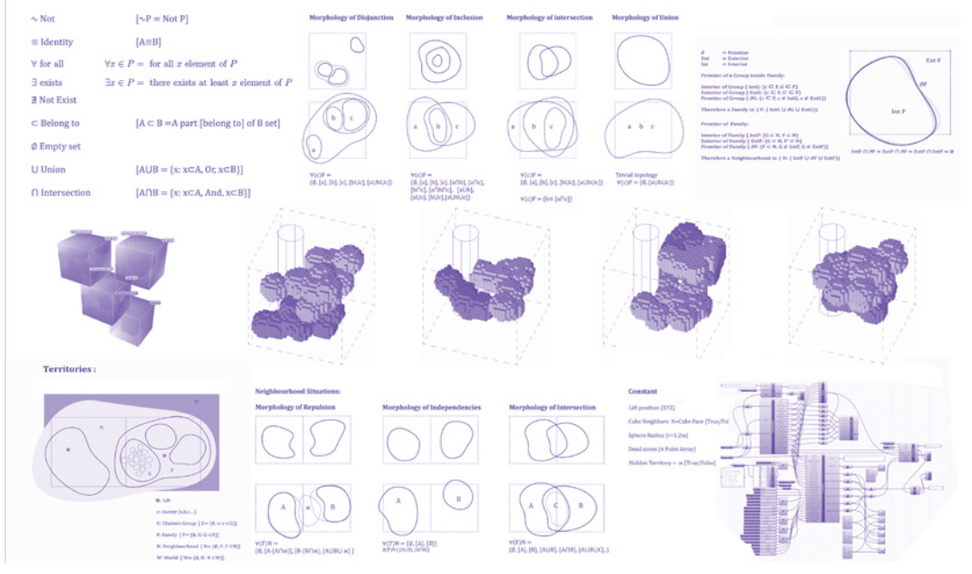
3 As Collin Milburn ascertains in the essay *Nanotechnology is the Age of Posthuman Engineering*, the dawning of this discourse as a scientific discipline creates a schism between science and science-fiction and yields past and present cyborgian speculation into present and future forms of corporeality. See further Colin Milburn, 2002. "Nanotechnology in the Age of Posthuman Engineering: Science Fiction as Science" in *Configurations* (2003), pp. 285

4 Luciana Parisi, "The Nanoengineering of Desire" in *Queering the Non/Human* (2008), pp. 283

5 With Donna Haraway's publication of *Simians, Cyborgs and Women* (1991), many feminists within Science Studies have strived to demonstrate that the historical correspondence between sex and gender, natural and cultural and the biological and the sociological is based on an ideological reification of the natural realm (as is revealed by the life-sciences) as the sole authority concerning legitimacy. Thereafter, queer theorists quickly began to expose the material-semiotic constructions of sexuality and sexual difference by accentuating the artificiality of the body. Most recently, with the exponential advancement of biotechnology, sex and sexuality can become complete indeterminate topographies.

its ideological subsumption to processes of capital also affords the possibility of its immanent redefinition and emancipation.

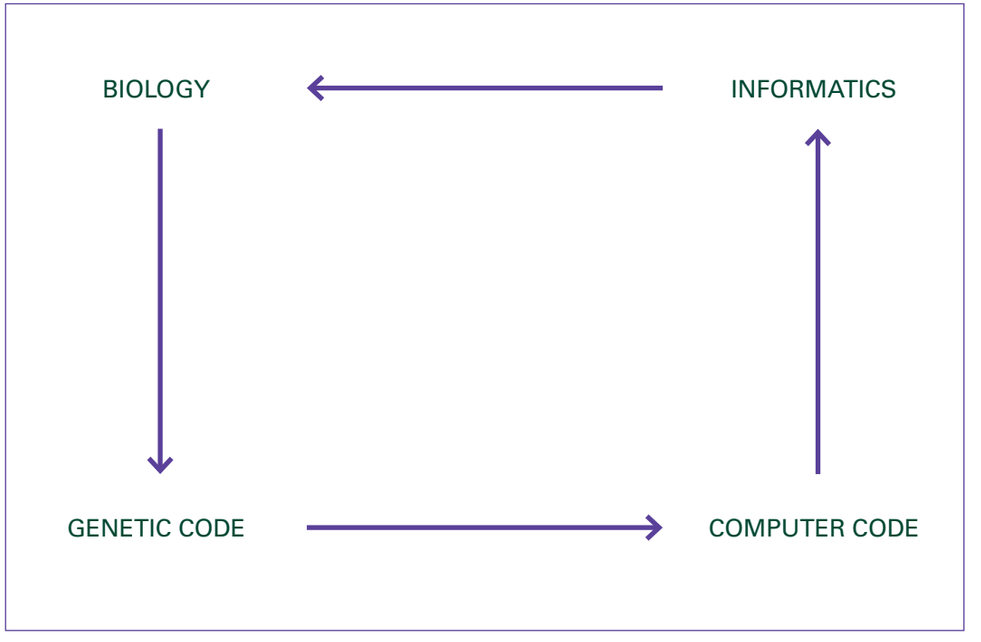
R&Sie(n)'s 2011 project *An architecture "des humeurs"* demonstrates the limits of customization within a medicinal discourse of nanotechnology through the medium of architecture while critically positing the project of architecture itself. By putting in question the architectural subject, *who* architecture is for, R&Sie(n)'s project is a critical response to the modern project as it is predicated on an ideal subject which architecture transcendentally realizes. *An architecture "des humeurs"* does not so much reject the latter but takes it to its sublime and radical limit, identifying the potential for any human subject, whatever its definition may be, to have its origin in its constituent body. As such, architecture explicitly addresses the *body*, as opposed to the aforementioned examples where architecture is put in relation to the *human*, preconditioned and mediated as it is by liberal humanism (Cerdá), distraction and latency (Eisenman), consciousness and desire (Lynn), or living and capital (Elemental). By reading and algorithmically interpreting the future resident's



R&Sie(n), *An architecture "des humeurs"*, 2010. Credit: New-Territories / R&Sie(n), Research as Speculation

physiological and chemical levels to ultimately determine what type of space they will inhabit, the body to which R&Sie(n)'s project responds to is crucially not the body as an instrument of the mind, but a fundamentally foreign and unknown agent, yet with an immanent presence and *necessarily* reconcilable.

The potential to subvert a series of ideological propositions, that in modern history materialized a transcendental model of what the human should be, can only be reached through the invention of another set of presuppositions and hypotheses. In Arakawa + Gins we discover another "Architectural Body" in which the modern abstraction of the body is located in the most overlooked and basic characteristics of architectural inhabitation. Their work, as is exemplified in their *Bioscleave House* and *Mitaka Lofts*, seeks to create a space which cannot be ignored, such as it is by the very neutrality of space, through the implementation of various somatic devices such as the use of bright colors, large geometries, and an enigmatic undulating textured floor. This strategy, claimed to have corporeal and psychological benefits, situates the dynamic engagement of a body with a space as the immanent process through which notions of *both* the 'human' *and* 'architecture' emerge. The work of Arakawa + Gins does not so much ignore the liberal humanist paradigm



Material equivalence cycle for a post-organic ontology.

Arakawa + Gins, *Bios*cleave House *(Lifespan Extending Villa)*, 2004. (Photograph by Léopold Lambert. http://thefunambulist.net/2012/10/29/arakawagins-domesticity-in-the-reversible-destinys-architectural-terrains/)

as it reflects upon the nature of scientific and social thought by embracing its radical historical contingency, and as such, creating a space for re-signification.

If we attempt to visualize the medicinal trajectory liberal humanism has taken since its historical inception, we find it to be cyclical. As such, if we were to attempt to locate our present historical moment we could claim to be returning from medicine's apex of information to the starting point of biology. This indirect profile view of the biological leads to the conclusion that what is perhaps most needed for an ontological re-categorization of the 'human' is a not a further mediation of what we think the 'human' can be, but a careful study and consideration of where 'humanity' comes from: the locus of the 'human', the body as a metaphysical object.

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THE MILIEU INTÉRIEUR
MATT JOHNSON

The cranium is a space-traveler's helmet.
Stay inside or you perish.
Vladimir Nabokov, *Pnin.*

Lunar Dust

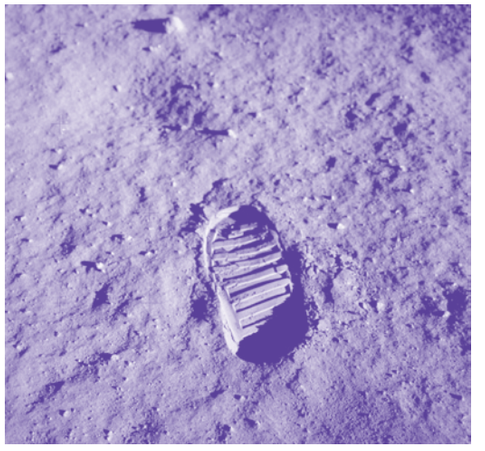
In 1969, as a part of the Apollo 11 spaceflight, Neil Armstrong and Buzz Aldrin became the first humans to physically touch the surface of another planet. [Fig 1] Back inside the command module after three hours on the moon's surface, they began their return journey to Earth. Upon removing their helmets, they realized that lunar dust was filling the gravityless space: it had been tracked in on their boots, space-suits, and equipment. It coated every surface, floating in the air and smelling strongly like spent gunpowder or desert rain. As Armstrong explained:

> *we planned to sleep with our helmets and gloves on for a couple of reasons. One is that ...we wouldn't be breathing all that dust...Our cockpit was so dirty with soot that we thought the suit [oxygen] loop would be a lot cleaner.*[1]

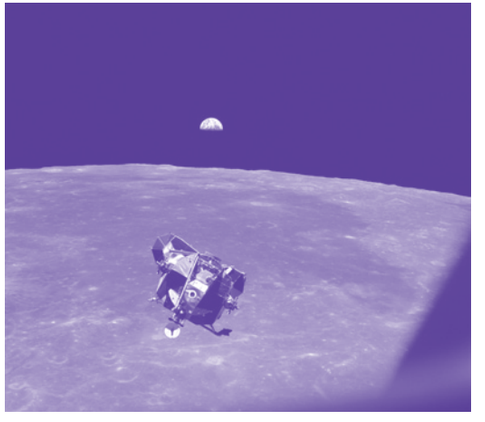
The moment when their lunar module descended back through the atmosphere, to crash down in the Pacific Ocean, therefore signaled the first time that alien dust had come into contact with our planet. Because of the remote possibility that the astronauts would bring with them a space-pathogen on their return, within minutes of the module opening after its splashdown, they were quarantined in Biological Isolation Garments (BIGs) and placed in isolation for twenty-one days, rinsing daily with betadine to remove any dust attached to their skin.[2]

Until that moment, Earth had been regarded as an immunological bubble—a vast hermetic space enclosed in an atmospheric shell. But it had now been penetrated by an extra-terrestrial artifact, the command module Columbia and its three astronauts. This minute vector of a potentially epidemic space-pathogen forced us to reckon with the idea of the Earth as nothing more than a membrane encasing a system in fragile equilibrium. Or rather a series of nested systems: from human body, to the glass astronaut's helmet, to the command module, to the planet.

Apollo 11 and its conditioning systems suddenly suggested an idea that had been latent in architecture since at least the beginning of the 20th century. Buildings, with their newly networked control systems and thermally broken envelopes, were becoming atmospherically akin to the space shuttle. If buildings are "machines for living in," they are *most like* machines in terms of their atmospheric, homeostatic attributes—the dials and control systems by which we regulate temperature, air, and light. This homeostatic control has only increased with new digital building technologies and home automation systems. The possibility I'd like to raise here is that a homeostatic idea about architecture has been embedded within and even central to Modernism, hiding in plain sight as it were, waiting to be clearly articulated. There was a moment in the 1960s when such thinking seemed primed to move to the fore. Cybernetic concepts were everywhere. Firms like Haus-Rucker-Co, Coop Himmelblau, Archigram, and Cedric Price theorized new ideas about self-regulating interior space. Reyner Banham proclaimed the centrality of atmosphere and environmental systems in his visionary 1967 book, *The Architecture of the Well-*



Buzz Aldrin's Bootprint in Lunar Dust



The Eagle Lunar Module

The Apollo 11 Crew in Biological Isolation Garments

1 NASA. *Apollo 11 Technical Crew Debriefing.* July 31st, 1969. p. 81.
2 This quarantine had only days earlier been mandated by Congress as the Extra-Terrestrial Exposure Law. The law, passed in July of 1969, just days before the Apollo 11 mission, applied "to all NASA manned and unmanned space missions which land or come within the atmospheric envelope of a celestial body and return to the Earth. The law made it illegal for Americans to contact or engage with extra-terrestrials, their equipment, or their belongings. It also implemented a mandatory quarantine period for any person who may have come into contact with extra-terrestrials. 14 CFR Part 1211 of the Code of Federal Regulations

Tempered Environment.[3] At the time, Banham's ideas appeared to have the potential to act as a counter-history to techno-formalist readings of Modernism such as Giedion's *Space, Time and Architecture*. But by the early 1970s this broad ecological theorization was dissolved into other prevailing architectural agendas and is only recently becoming central again.

My broad point is that such thinking is not merely a matter of adopting an "atmospheric" approach to architecture, or of imagining an architecture of climatic effects. Thinking homeostatically and cybernetically about architecture—in a broad sense, not simply as this year's theoretical trend—has the potential to positively transform the discipline. However, in order to frame this as a theoretical question, it's first necessary to explain a bit about the history of homeostasis.

Homeostasis: the Environment Within

In the late 1860s, a French physiognomist named Claude Bernard developed a concept that eventually became fundamental to our understanding of how biological systems work. He called it *le milieu intérieur*, or the "environment within," which indicated the human body's ability to maintain equilibrium in spite of constantly fluctuating exterior environment. In the late 19th Century, this was a radical concept, arising as it did in a period when physicians still believed in the ancient Hippocratic idea of "humors"—fluids such as bile, phlegm, and blood that regulate one's health. Bernard said of his new concept of the milieu intérieur,

> *all of the vital mechanisms…have one goal: to maintain the uniformity of the conditions of life in the internal environment. The stability of the internal environment is the condition for a free and independent life.*[4]

Bernard's *milieu intérieur* was later elaborated into the more detailed concept of *homeostasis*, or the self-regulation of biological organisms. Imagine a person in a northern climate venturing from a fire-warmed interior into a snowstorm. The body adapts to this sudden atmospheric shift of temperature, humidity and light through an intricate series of calibrations. The physiologist Walter Cannon, writing in 1932, described even voluntary behaviors as homeostatic—shivering, rubbing yourself with your hands, putting on or taking off clothing, wiping away

3 Banham, Reyner. *The Architecture of the Well-Tempered Environment.* London: Architectural Press, 1969.
4 Bernard, C. (1974) *Lectures on the phenomena common to animals and plants.* Trans Hoff HE, Guillemin R, Guillemin L, Springfield (IL): Charles C Thomas

sweat.[5] We also subcontract out homeostatic regulation to external technologies such as fans, heaters, and clothing, allowing the body to use less energy in its attempt to reach equilibrium. This is exactly what philosophers such as Norbert Wiener meant when they coined the term cybernetic: an external feedback and control system that formalizes Bernard's *milieu interieur*.[6]

Buildings, too, can be read as an externalized self-regulation system whose primary function is to assist the body in thermoregulation. In heat, we seek shade; in cold, interior warmth. We could even describe the history of architecture as an attempt to achieve *building homeostasis*. Historically, architecture operated as a fairly "leaky" thermodynamic system. The earliest models of what might be called building homeostasis involved thick walls, thermal mass, and fires (such as stone castles) or open walls, wind-scoops and brise soliels (such as desert ramadas.) Supplementary thermal technologies such as blankets, layered clothing, fans, iced drinks, and even water mist helped to alleviate extremes of climate. Siegfried Giedion put it more poetically, "the warm damp American climate, settled by northern peoples, stimulated from the first a desire for ice and cool drinks."[7] But with the invention of air conditioning by Willis Carrier in 1902, our ability to regulate temperature and humidity in buildings increased dramatically. [8] We could now inoculate interior space. If in the 1860s Bernard had elaborated a theory about maintaining bodily equilibrium in spite of any external condition, then it seems possible to draw out a similar desire to achieve architectural equilibrium in the history of HVAC and conditioning systems. Could there be a "Bernardian" reading of buildings too?

Immunized Space

Early Modernists recognized that new building systems would allow for the stabilization of the interior climate—for instance, Le Corbusier was able to dictate an ideal interior temperature at 18° C, or roughly 65° F. Ever since, this condition of normalizing air temperature has meant sealing buildings up, creating an immunological space that is relatively pure and rela-

5 Gross. p. 384.
6 Gross, Charles. "Claude Bernard and the Constancy of the Internal Environment." The Neuroscientist, 1998. p. 382.
7 Giedion, Siegfried. Mechanization Takes Command. New York: Oxford University Press, 1948. p. 596.
8 See Margaret Ingels' biography of Carrier for an interesting history of the invention of the air conditioner. Ingels, Margaret. *Willis Haviland Carrier: Father of Air Conditioning.* Garden City: Country Life Press, 1952.

tively stable, more and more like a lunar module. Even as buildings became more transparent, less physically substantial, their ability to isolate climate increased through new thermal barriers.[9] In the 20th century, this trend manifested as a concern for prismatic modernist forms and a glassy transparency, with the envelope as a mediator between the interior and exterior. Thus, influential works such as Mies Van Der Rohe's Seagram Building or the Lever House by SOM were fundamentally about sealing spaces off almost hyperbarically—windows were siliconed shut and the inside ceased to interact with the outside. [Fig 4] Mies Van Der Rohe's concept of *beinahe nichts* (almost nothing) meant the necessary subversion of any overtly technical details within clean and barely-there spaces. Or, as Le Corbusier put it, "for Ledoux, it was easy—no pipes!"[10] (Certain exceptional buildings such as the Centre Pompidou wear their color-coded systems on the outside, like a body turned inside out, and serve as critical counterexamples to this trend.) The imperative within Modernism toward a pure and minimal architecture meant that the profession began to separate into cadres of designers on the one hand, and technicians on the other. This artificial divide between the artistic and technological sides persists today, with many designers engaging technics either as a wholly separate discipline, as a set of systems to be hidden within the poché space of a building, or as an afterthought. A bipolar view of architecture—design versus technics—may have begun during the Enlightenment but became far more pronounced as modern innovations transformed building technologies.

This Modernist idea of a pipeless, homeostatic, sealed architecture gave rise in the 1960s both to massive geoengineering proposals and to tongue-in-cheek critiques of our newly isolated interior lives. One thinks of Buckminster Fuller's proposal to seal central Manhattan in a vast geodesic dome: the temperature for a hundred blocks would be centrally controlled. Windows in buildings could remain open. The interior and exterior temperature would be identical, presumably around 72°, and would never vary. In the same period but at a smaller scale, the Austrian art group Haus-Rucker-Co. proposed a series of plastic, atmospherically isolated structures seeming to balloon from the windows of historic buildings. These projects, collectively called

9 For an historical account of how architecture was transformed by mechanical systems in the modern period, see Banham. 1969.

10 "Pour Ledoux, c'était facile - pas de tubes!" This phrase was inverted by Reyner Banham to describe how modern buildings had somehow become all tubes, all pipes. See Banham, Reyner. "A Home Is Not A House" *Art in America* #2. April 1965.

Oases, offered a means for viewing the city prismatically but without actually having to venture outside. In another project titled *Mind Expander Helmet*, they suggested shrinking this "oasis" to the size of a plastic helmet providing sensory feedback and data—your fully conditioned space travelling with you. Francois Dallegret and Reyner Banham's *Environment-Bubble* also comes to mind:, "a plastic dome inflated by conditioned air blown out by the package itself."[11] The Environment-Bubble is nothing more than a transparent membrane enclosing an elaborate entertainment system sitting in the middle of the space.[12] Many other firms were proposing similarly bubblelike architectures, from Cedric Price's pneumatic urban

11 Banham, Reyner. Quoted in Dessauce, Marc. The Inflatable Moment: Pneumatics and Protest in 1968. New York: Princeton Architectural Press, 1999. p. 133

12 Banham, Reyner. "Stocktaking." *Architectural Review* 127, Feb 1960. p. 93.

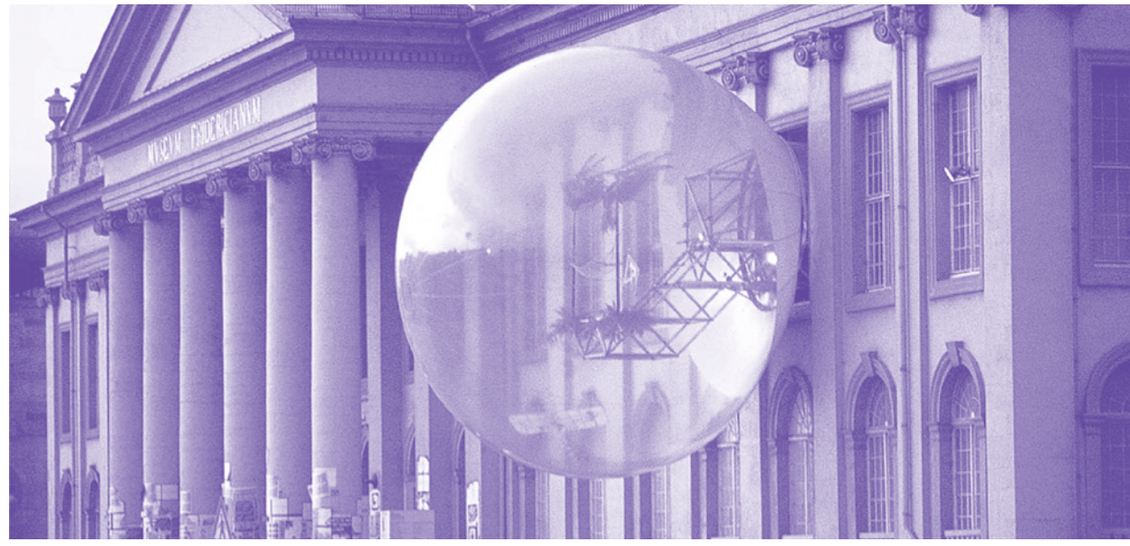
Lever House, Skidmore Owings & Merrill

Centre Pompidou: A Body Turned Inside Out © Dan Perry

Dome Over Manhattan, Buckminster Fuller © Buckminster Fuller Institute

Mind Expander Helmets, Haus-Rucker-Co. © Laurids Ortner/Haus-Rucker-Co.

Environment-Bubble, Francois Dallegret & Reyner Banham © Reyner Banham



Oasis #7, Haus-Rucker-Co. © Laurids Ortner/Haus-Rucker-Co.

furniture to Coop Himmelblau's *Basel Event*, in which they strolled around the city in a giant plastic ball. These projects were highly speculative, rarely backed up with any real science about regulating climate. As with earlier Modernist architecture, the designs seemed to decouple (or even ignore) the technical from architecture. But they provoked an idea of a future in which walls might dissipate completely, allowing us to live inside nothing more than a cloud of scented, purified air.

Bio-Hybrids

The profound dualism between design and technics did not originate in architecture, however. It was already a part of the larger cultural trend toward modernization, as Bruno Latour illustrates in his book, *We Have Never Been Modern*. Latour argues that since the enlightenment we have separated the worlds of the Humanities and social sciences (or what he calls the *symbolic*) from the world of the hard sciences (what he calls the *material*.)[13] In his view, these dualisms between the symbolic and material should merge in what he calls the "non-separability of things and signs."[14] The approach suggested by Latour is one in which scientific knowledge is hybridized with design.

13 Latour, Bruno. *We Have Never Been Modern.* Cambridge: Harvard University Press, 1993.
14 Latour. *We Have Never Been Modern.* p. 135.

Applied to architecture, Latour's theorization would result in a kind of seamlessness of the symbolic and the technological, a new cybernetic mode. Yet it appears that when one can manipulate fluctuations of temperature and sound within a house instantaneously from a small touchscreen device, we've already achieved seamlessness between digital control and phenomenal effect. *We* are the feedback and control system that regulates building homeostasis. Manfred Clynes and Nathan Kline's idea of a Cybernetic human or Cyborg is apparently becoming real, an "exogenously extended organizational complex functioning as an integrated homeostatic system, unconsciously."[15] The architectural experiments of the 1960s attempted to blur the artificial divide between the technical and the organic. But most of these experiments were purely speculative, in the sense that technology could not realistically achieve the goals of much of the imagery being produced. Now, in the era of Lasik surgery, cochlear implants, pacemakers, prosthetics, genetic sequencing, multi-touch screens and so on, we might argue that the cybernetic human is fundamentally a reality. As Antoine Picon has remarked, the image of our age is not the Renaissance's humanist subject, nor even Le Corbusier's Modulor, but the cyborg, which Picon says is "not a utopian figure, [nor, I would add, a dystopian one] but the result of the full use of existing technologies."[16]

What Latour and others theorize is a shift in every discipline toward *bio-hybridity*, a dissolving of the boundaries between between technics and design. But this condition was already emerging almost a half century ago as part of a cultural turn toward the sciences of life—with the rise of bioengineering, cloning, transgenics, and so on—and the corrective realignment of our relationship to the environment from one of dominion to one of ecological symbiosis. Thus politics becomes *bio*politics, shifting from a concern for social constructs to how those social constructs are biologically formed, mediated and controlled;[17] engineering becomes *bio*engineering; technics becomes *bio*-

15 Manfred E. Clynes, and Nathan S. Kline, (1960) "Cyborgs and space," *Astronautics*, September, pp. 26–27 and 74–75; reprinted in Gray, Mentor, and Figueroa-Sarriera, eds., *The Cyborg Handbook*, New York: Routledge, 1995, pp. 29–34.

16 Picon, Antoine. "Architecture, Science, Technology and the Virtual Realm." In Picon, Antoine and Alessandra Ponte, eds. *Architecture and the Sciences*. Princeton, NJ: Princeton Architectural Press, 2003. p. 310.

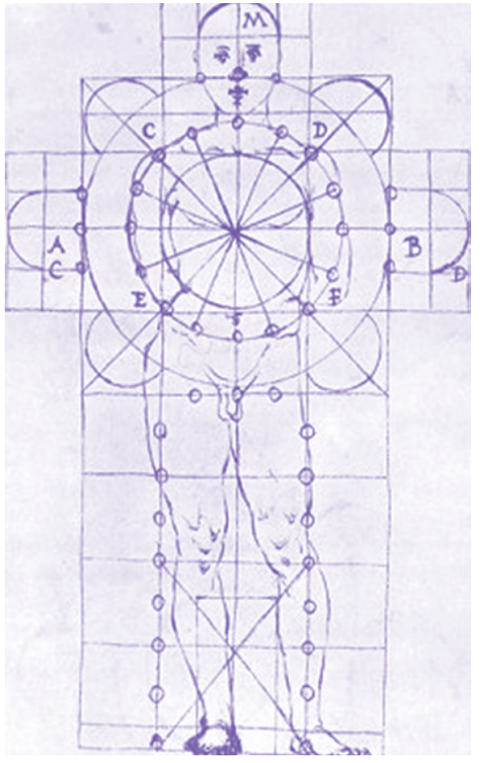
17 For more on biopolitics, see Foucault, Michel (1997). *The Birth of Biopolitics: Lectures at the Collège de France, 1975-1976*. New York, NY: St. Martin's Press. Agamben, Giorgio. *Homo Sacer: Sovereign Power and Bare Life*. Stanford: Stanford University Press, 1998. And Hardt, Michael and Antonio Negri. *Multitude: War and Democracy in the Age of Empire*. New York: Penguin Books, 2005.

technics.[18] The primitive hearth fire has given way to the cybernetic LED display controlling a mechanical conditioning system: both warm you, but in different ways.

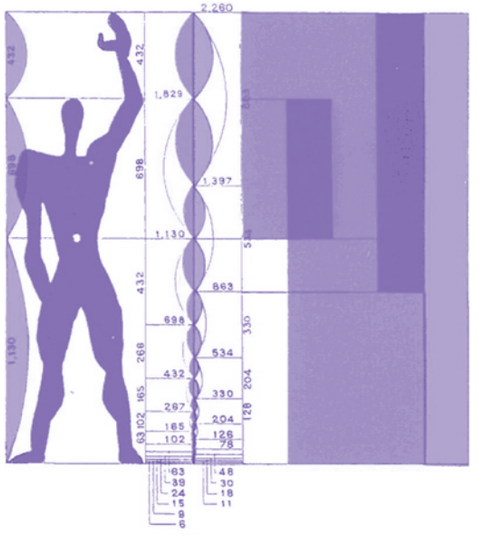
This so-called cybernetic revolution has prompted much discussion of a "human 2.0," Steve Fuller's idea of an exogenously enhanced human who no longer takes the "normal human body as a given."[19] But if we are willing to restructure our understanding of what it means to be human in the midst of this cybernetic moment, should we not also be willing to reformulate the rules of architecture, in order to create an architecture 2.0? Insofar as architecture has co-evolved alongside humanity, our current transformation implies a major evolutionary shift that might result in a much more integrated architecture vis-à-vis its human users. We already see the outlines of this shift in the work of Phillipe Rahm, François Roche, Jürgen Mayer, Diller + Scofidio, Sean Lally, and others. In 2011 Rahm and landscape architect Catherine Mosbach won a competition for a new park in Taiwan, which they titled *Phase Shift Park*. Their intention was to create a park that would learn genetically from its users, and responding to their needs micro-climatically through shifts in heat, humidity, and pollution. This is a potentially new type of park space, not simply green and

18 This transformation was already forecast by Lewis Mumford as early as 1970. See Mumford, Lewis. *The Pentagon of Power: The Myth of the Machine Volume 2.* New York: Harvest Books, 1974.

19 See, for instance, Fuller, Steven. *Humanity 2.0: What It Means To Be Human Past, Present, and Future.* London: Palgrave Macmillen, 2011. And Ray Kurzweil. "Human Body Version 2.0," Presented at the *Future of Life Conference*, 2003 and published on his website. http://www.kurzweilai.net/human-body-version-20



Renaissance Church as a Diagram of the Body



Le Corbusier's Modulor © Fondation Le Corbusier

Image from Catherine Mosbach and Philippe Rahm's *Phase Shift Park, 2011* © Philippe Rahm

Image from Catherine Mosbach and Philippe Rahm's *Phase Shift Park, 2011* © Philippe Rahm

landscaped, but metabolic and atmospheric as well.

One also thinks of the ten-year-old Blur Building by Diller+Scofidio, surrounded by an ever-shifting cloud of water vapor. One of the most interesting aspects of the proposal, however, was never realized: the *braincoat*, a transparent coat embedded with sensors that would allow visitors to communicate both with other guests and with the building itself, registering users' emotional states in changing colors.[20] And many of architect Sean Lally's recent proposals deal with similarly metabolic spaces. For instance, his design for the Estonian Academy of Art frames the entire project around an interiorized "climatic lung" that would nurture lush gardens in the midst of Tallinn's harsh winter. Wanderings uses amoebalike benches filled with heated pink liquid and to create a series of hearth conditions in a cold climate.

Some of the most intriguing examples, however, are at a more domestic scale. Mathieu Lehanneur's designs for metabolic household implements provide fresh air (*O*), heat (*C°*), white noise (*dB*), or ultraviolet light (*K.*) They indicate an extension of homeostatic thinking into the domestic domain: home appliances for metabolic stabilization. This architectural external-

20 "Braincoat." Project Description Diller Scofidio Renfro website. www.dsrny.com.

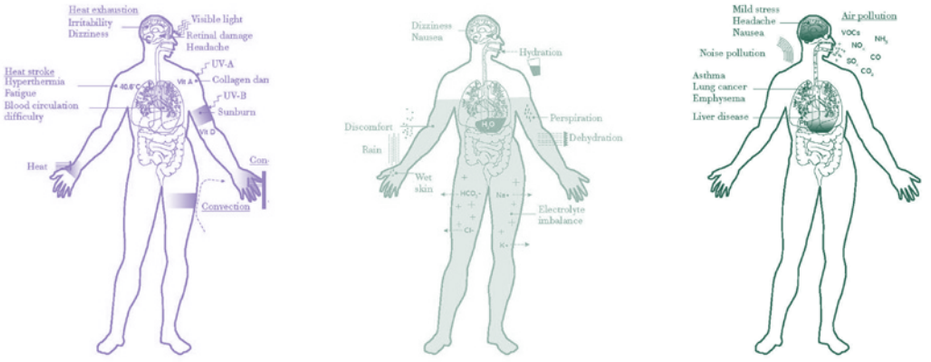
izing of internal metabolic or even emotional states is, I would argue, entirely new. The subject of this architecture is no longer the Modulor, a fundamentally geometrical construct delineated from Da Vinci's Vitruvian Man. Instead, it is a cybernetic being whose body becomes a sensing mechanism for an external environment in perpetual flux, Mosbach and Rahm's Phase Shift Human.

Modernism often elevated tectonic, spatial, and semantic questions above those of atmosphere and effect. But, as numerous recent projects are demonstrating, architecture can address all of these things at once, which is why the old bipolar debates regarding form versus function so frequently appear as outdated artifacts of high Modernism. The certainties of Modernism—its reliance on compositional technique and tectonic purity—are hard to reconcile with a new conception of architecture based on atmospheres and effects. An ecological sensibility should extend beyond simple buzzwords to become a habit of thought,

Mathieu Lehanneur's C°
© Mathieu Lehanneur

Mathieu Lehanneur's K © Mathieu Lehanneur

Mathieu Lehanneur's O
© Mathieu Lehanneur



Catherine Mosbach and Philippe Rahm's *Phase Shift Human* © Philippe Rahm

as Gregory Bateson said.[21] But the thinking required for such a shift is inherently complex and unstable, and therefore different from the universalizing certainties of Modernism. Bateson, in his schismatic essay "From Versailles to Cybernetics," raises a pertinent disciplinary question that we now face, namely, how to not merely work within the rules as given, but how to change the rules. What is important in history, he says, is the moment at which "the bias of the thermostat is changed."[22] Seen in this light, many of the central movements in 20th century architecture (Postmodernism, Deconstructivism, et al.) appear largely stylistic—not reworkings of the totality of rules bounding architecture, *à la* Bateson, but rather rearrangements of the operations *within* a set of rules already given at the outset of Modernism. Below the surface of architecture's disciplinary arguments, a conceptual fault line appears: the increasing non-separability of culture and nature and the integration of the biological with the technological.

To bring the argument full circle, the Apollo 11 astronauts were arguably the first fully cybernetic humans, a non-separable matrix of the biological and the technological. What they undertook when they broke through the Earth's membrane, twice, was not simply an exploration of near-outer space. It was a philosophical engagement with our concept of interiority as well. What did it mean to dwell inside of a system, or to cross the threshold between a system's inside and its exterior surroundings? For millennia, our architecture was porous, incomplete, subject to the fluctuations of weather and climate. But now, in the age of space suits and air conditioning, we are able to live hyperbarically. The Apollo 11 mission indicated a possibility for dwelling completely inoculated from the outside, regardless of atmosphere or external effects. If our living systems are now able to mimic our metabolic systems, then buildings might cease to be machines for living in and would be more like homeostatic bodies nearing a permanent equilibrium. But the inherent irony is that even as our theories about architecture become more ecological, more hybrid, the architectural membranes within which we inoculate ourselves become thicker and more resistant to external atmospheric effects. Interior air is increasingly separated from outside air—pure, stable, clean. The building is becoming a kind of space-traveler's helmet…but should it be?

21 Yet even Bateson admitted that he had difficulty thinking in this new, ecological mode that he'd identified. "The most important task today, perhaps, is to learn to think in the new way. Let me say that *I* don't know how to think that way." In Bateson, Gregory. *Steps to an Ecology of Mind.* Chicago: The University of Chicago Press, 2000. p. 468.

22 Bateson. "From Versailles to Cybernetics." In *Steps to an Ecology of Mind.* p. 484.

FORMATION AND VARIATION: WOLTERECK'S CONCEPT OF *REAKTIONSNORM* AND THE POTENTIALS OF ENVIRONMENT

RYAN R. LUDWIG

Throughout the course of man's development of a modern civilization he has had a propensity to seek control of his surroundings, to harness its powers and redirect them for his own use through the invention and implementation of various technologies. In the 1934 book *Technics and Civilization* the historian Lewis Mumford said: "The unwillingness to accept the natural environment as a fixed and final condition of man's existence had always contributed both to his art and his technics: but from the seventeenth century, the attitude became compulsive, and it was to technics that he turned to fulfillment."[1] Mumford's use of the word "technics," as opposed to "technology" or "tools" described not just the mechanical *products* of technological innovation, but also its mechanized *processes* of organization, and perhaps most importantly reflected the underlying change in cultural values that made these advancements possible. This compulsive seventeenth century shift towards technics and away from art went hand-in-hand with a fundamental shift in the physical sciences towards a reductionist, predictable, and mechanically causal experimental method. This resulted in a simplified linear definition of environment and reinforced the idea that it could be rationally controlled. Heightened further by the industrial revolution of the late nineteenth century, this shift saw its most prolific effect on architecture in the development of Modernism, a movement that espoused itself as rational, functional, mechanically driven and totalizing. For Mumford what became most significant in separating modernity from past epochs was the dominance of technics over every aspect of human existence.

Through the design and construction of localized environments intended for human occupation, architecture has effectively become the indispensable product of man's unwillingness to accept the natural world, the synthesis of both art and technics towards the sustainment of the human organism. According to Mumford, the motivation behind all of man's technological development was an attempt "to manufacture outside of the body a set of conditions more favorable toward maintaining its equilibrium and ensuring its survival."[2] In this sense architecture could be thought of as a partial substitute for biological adaptation, an extension of the human organism itself through environmental modification, construction and management. Taken further, by providing direct and deliberate stimuli towards its inhabitants, architecture could become an *active* participant in future human development. If architects are to accept such a role they must redefine their responsibilities and priorities around the human, not just through, or by way of new technics, but also by effectively reincorporating the potentials of art within these human/environment interactions. The artist and architect partnership of Arakawa + Gins have argued that through a closer and more complex alignment of people and architectural surrounds there exists the potential for humans to sustain their lives indefinitely, and that "a procedural constructing of the world will constitute a way for our species to take evolution into its own hands."[3] Producing such a reciprocal relationship between architecture and inhabitant may only be achieved through a re-conceptualization of the linear reductionist model of environment and the evolution of individuals, conceiving them instead as both a part of the same interactive, dynamic series of spatio-historical events.

Although the reductionist model, mutually reinforced by the shift towards technics, has produced substantial scientific advancements towards problems that can be studied in isolation (particularly in the fields of physics, chemistry and molecular biology), it provides only an approximate conception of the world. This "Cartesian method" understands a system through its constituent parts reducing the complexity of interrelationships and representing them inexactly. The population geneticist Richard Lewontin, one of the most prominent and outspoken critics of genetic determinism (a result of Cartesianism in biology) has voiced great concern over the fact that, because of its perceived scientific successes, it has been regarded as more than a method of investigation, but rather an accurate reflection of how things really are. Not simply a representation, but reality itself.[4] The adherence to this reductionist model was for many

1 Lewis Mumford, *Technics and Civilization* (New York: Harcourt, Brace & World, 1934, 1964) 52.

2 Mumford, *Technics and Civilization*, 10.

3 Madeline Gins and Arakawa, *Architectural Body* (Tuscaloosa: The University of Alabama Press, 2002) xv-xix.

4 Richard Levins and Richard Lewontin, *The Dialectical Biologist* (Cambridge, MA: The Harvard University Press, 1985) 2-3.

scientists an opportunistic strategy for more assured scientific "successes." With the implementation of these methods, environment was regarded as something to overcome but, for Lewontin, environmental conditions could not be separated from the definition of the organism as both were actively interrelated throughout the process of evolutionary development.

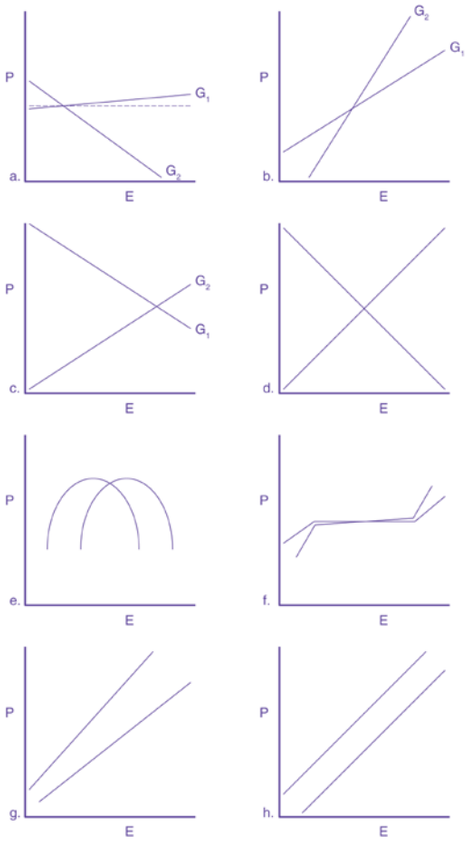
It has been with the steady progress of more advanced twenty-first century technics, particularly in digital computational technologies, that architects have been able to widely acquire the necessary means for investigating this dynamic space of inter-action and development. The architectural historian Antoine Picon has suggested that these "electronic" technologies have begun to change our perception of the relationship between man and machine from one of "dramatic confrontation" to one where technology is "assimilated into a kind of pervasive environment, a kind of landscape."[5] The implementation of these new digital technics by architects reflects a relationship Greg Lynn has characterized as "animate."[6] Lynn describes animate form not as one that displays "motion," but as one "defined by the co-presence of motion and force at the moment of formal conception." For architects this conception is the product of a Leibnizian space of generation (dynamic, viscous and composed of forces), instead of an idealized Cartesian space (static, linear and abstract).[7]

However, as the technics necessary for engaging with animate form available for use by architects has expanded exponentially since Picon's and Lynn's initial speculations, the sophisticated utilization of these technologies towards architectural design has fallen considerably short of their projections. Although the tactical use of these technics is not inherently negative, it is simply limiting, their application has often been towards the production of complex form, geometries, shapes, and/or patterns. From the onset of amorphous blobs,[8] to smooth undulating surfaces of gradual change,[9] to the "style" of parametricism,[10] what we have often been left with is an emphasis on form, its representation and image as the dominant products of architectural production. Unfortunately, it is hard not to place much of Lynn's work since the publication of his book *Animate Form* (1999) into this category.[11]

Despite Lynn's calls for a new type of architectural "contextualizim"[12] and the implementation of these new parametric, scripting and animation tools, the opportunity for the discipline to both "retool and rethink"[13] itself is still necessary, and must be considered beyond the topological surface or digital technique to instead cultivate *active* relationships that are productive, capable of instigating various effects, inhabitations of space and participatory experiences. The architect Sean Lally (Weathers) has made a similar claim in his text "Potential Energies" when he extends Lynn's notion of the 'performative envelope' to consider it not just as a representation of the forces that inform its geometry, but, through the use of simulative digital resources, is able to participate "on" the 'active context' in which it's situated.[14] What may provide architects with more meaningful sophistication of these computational tools is to consider them not as form generating, but form finding; simulators of environmental potentials capable of producing specific effects. In order to speculate further on the effects of these potentials we should examine fully Lewontin's criticism of the reductionist model in genetics and his conception of a less representational active environment.

Having been originally conceived as a one-to-one correspondence between gene and trait, the specificity of gene action (genetic determinism) was a presumption since the inception of genetics and persisted, though increasingly mitigated, through-

5 Antione Picon, "Architecture, Science, and Technology," in *The Architecture of Science*, ed. Peter Galison and Emily Thompson (Cambridge, MA: The MIT Press, 1999) 325-326.
6 See Greg Lynn, *Animate Form* (New York: Princeton Architectural Press, 1999), 9-43.
7 Lynn, *Animate Form*, 9-15. He goes on to make the point that it has only been possible through the invention of new technologies for modeling and animating space that notions of *topology*, *time* and *parameters* may be used by the architect to finally produce animate forms.
8 See Frank Gehry's Experience Music Project in Seattle, WA (2000); Peter Cook and Colin Fournier's Kunsthaus Graz in Graz, Austria (2003); Future System's Selfridges Department Store, Birmingham, UK (2003) and various projects by Hernan Diaz Alonso and Tom Wiscombe.
9 See Reiser + Umemoto's West Side Convergence Competition Entry in New York, NY (1999); Peter Eisenman's City of Culture of Galicia in Santiago de Compostela (1999-2011); Zaha Hadid's MAXXI – National Museum of the 21st Century Arts, Rome, IT (1999-2010) and the Heydar Aliyev Cultural Center in Baku, Azerbaijan (2007-2012).
10 See Patrik Schumacher's writing "Parametricism as Style – Parametricist Manifesto" (2008)
11 One example would be Lynn's design for the Ark of the World Museum (2003) located in the Costa Rican rainforest. It's composed of a series of attenuated 'vegetative' blobs which turn up to support a tensile fabric roof structure. Here the eco-center adopts the image of the ecology through the use of botanical floral elements and forms.
12 Lynn, *Animate Form,* 42, endnote #2.
13 Lynn, *Animate Form,* 41.
14 Sean Lally, "Potential Energies" in *Softspace: From a representation of form to a simulation of space,* ed. Sean Lally and Jessica Young (London: Routledge, 2007), 25.



Examples of different forms of reaction norms. In each case the phenotype (P) is plotted as a function of the environment (E) for different genotypes (G1 , G2). Credit: *American Journal of Human Genetics,* 26, Richard C. Lewontin, "The Analysis of Variance and the Analysis of Causes," 400-411, Figure 1, a-h, Copyright Elzevier (1974).

out the twentieth century.[15] The strongest form of genetic determinism claims that the phenotype[16] shows no response to environmental variation, only that in order for a trait to develop *an* environment is needed, but it does not matter *which* environment; a second "more moderate form of genetic determinism claims that genetic and environmental factors interact additively."[17] The continued persistence of genetic determinism prompted Lewontin to publish a paper titled "The analysis of Variance and the Analysis of Causes" (1974), perhaps the most influential contribution to the literature concerning the interpretation of behavioral genetics,[18] in which he challenged the supremacy of additive causal relationships between genotype, environment, and phenotype. Through an alternative analysis of variance in the performance of specific genotypes under a single well ordered, but changing environmental stimuli (such as temperature), Lewontin demonstrated that genotypic performance at one point in time is not necessarily an accurate predictor of performance at any future moment.

The perception of a general cause and effect relationship between genes

15 Sahotra Sarkar, "From Genes as Determinants to DNA as Resource," in *Genes in Development: Re-reading the Molecular Paradigm,* ed. by Eva Neumann-Held and Christoph Rehmann-Sutter (Durham: Duke University Press, 2006), 79.

16 Phenotype is the physical and psychological traits of an organism, both its appearance and its behaviors, from: Neil A. Campbell, *Biology* Third Edition (New York: Benjamin Cummings Publishing Company, Inc., 1993) 263.

17 Paul E. Griffiths, "The Fearless Vampire Conservator: Philip Kitcher, Genetic Determinism, and Informational Code," in *Genes in Development: Re-reading the Molecular Paradigm,* ed. by Eva Neumann-Held and Christoph Rehmann-Sutter (Durham: Duke University Press, 2006)178-179.

18 Griffiths, "The Fearless Vampire Conservator," 179.

and environment was demonstrated to be only an illusion. Lewontin's analysis showed that "the sensitivity of phenotype to both environment and genotype is a function of the particular range of environments and genotypes" resulting in a dynamic interactive relationship between them.[19] From this understanding it is not possible to separate out genetic factors and environmental pressures and every attempt to do so is founded upon a mistaken view of biological and environmental interaction.[20]

Lewontin argued that a more accurate description of this relationship was expressed through the concept of the *Reaktionsnorm,* or the Norms of Reaction (NoR), which graphically illustrates performance not at a single moment in time, but rather multiple moments, reflecting the *total* potentials of the genome and not only at an ideal, or selective instance. The historian of genetics Raphael Falk has credited Lewontin with reviving the concept of *Reaktionsnorm* from its early twentieth century originator Richard Woltereck, emphasizing the unpredictability of individual phenotypic responses once the genotype-environment interaction was considered over a wide range. Lewontin was able to effectively demonstrate "the fallacy inherent in the hopes of analyzing causes through linear models embodied in the analysis of variance, covariance, and path analysis."[21] This conceptualization of the individual suggests a dialectical relationship between organisms and the spaces they inhabit; environmental niches are not preexisting waiting to be filled by better adapted individuals, but instead they exist only in relationship to the organisms that occupy them, where both are constantly shaping and reshaping one another.[22] If we consider architectural spaces as localized environments for human inhabitation then, like the biological niche, they too may can not be defined separately from the individuals who occupy them. A closer examination of the concept of *Reaktionsnorm* may help us better understand this active relationship and the possibility for architecture to engage directly with human evolutionary potentials.

19 Richard C. Lewontin, "The Analysis of Variance and the Analysis of Causes," *American Journal of Human Genetics* 26 (1974): 400-411.

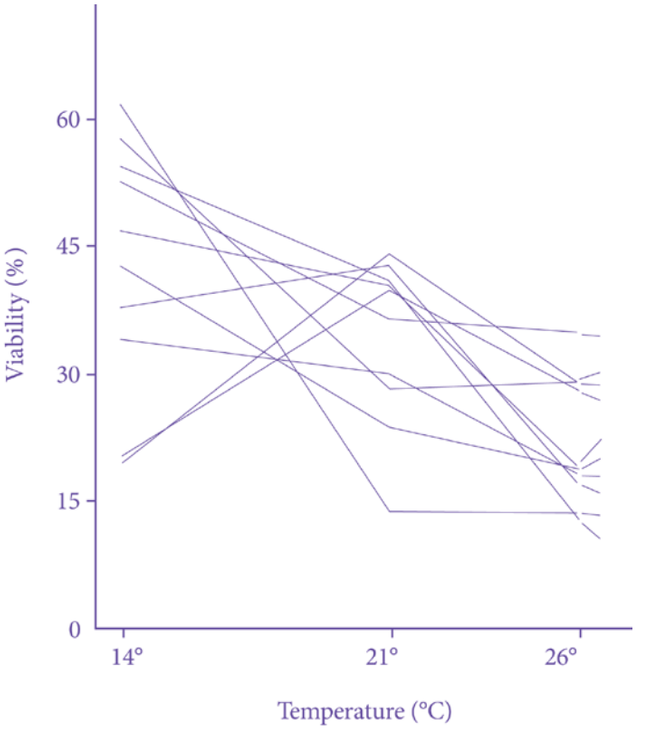
20 Michael Ruse, *The Evolution Wars: A guide to the Debates* (New Brunswick, NJ: Rutgers University Press, 2000) 223.

21 Raphael Falk, "Can the Norm of Reaction Save the Gene Concept?" in *Thinking About Evolution: Historical, Philosophical, and Political Perspectives,* ed. Rama S. Singh, Costas B. Krimbas, Diane B. Paul, and John Beatty (New York: Cambridge University Press, 2001), 131.

22 Michael Bradie, "Epistemology from and Evolutionary Point of View," in *Conceptual Issues in Evolutionary Biology,* ed. Elliott Sober (Cambridge, MA: The MIT Press, 1994) 466.

Although largely unknown to historians of biology,[23] the German zoologist Richard Woltereck (1877-1944) preceded Lewontin in providing an earlier conception of the individual as the product of genotype-environment interaction and is credited with the conception of the NoR as the comprehensive graphical and material representation of these interactions. In his 1909 publication *Weitere experimentelle Untersuchungen uber Artveranderung, speziell uber das Wesen quantitativer Artunterschiede bei Daphnien*[24] he came to the conclusion, after years of experiments conducted on morphologically distinct pure strains of Daphnia and Hyalodaphnia species,[25] that the genotype of an individual was less of a deterministic force and more of an enabling agent in the developmental process of phenogenesis.[26] Woltereck's experiments were designed specifically to address the debate of the day concerning the evolutionary mechanism responsible for species formation, "particularly to counter the mutationists' salutatory model with evidence of evolution as a continuous process which was guided, whether directly (neo-Lamarckianism) or indirectly (selection), by environment."[27] In his many experiments each pure line of individuals maintained their phenotypic traits (such as head length) consistently over several generations; however when the line was subjected to changes in environmental variables, varying phenotypic outcomes of these previously stable traits were routinely observed. The interrelationship of genotype and environment towards the production of the phenotype "was best represented, not as a constant, but as a curve which demonstrated the degree of the trait's development in a range of environments."[28] In order to fully visualize the phenotypic potential of the line's genome, Woltereck superimposed the series of curves onto a single comprehensive graph. As each curve described the phenotypic outcome of an individual genotype as it was influenced by a specific environmental stimulus these curves were not flat, but fluctuated unpredictably in relationship to the particular environmental factor being considered. It was apparent that the influences of external forces were vital

23 Jonathan Harwood, "Weimar culture and biological theory: A study of Richard Woltereck (1877-1944)," *History of Science* 34 (1996): 348. Harwood proposes that this might have been because he never attained a full professorship at a German University or because much of his later biological writings were primarily philosophical.
24 Translation: "Further investigations on change of species, specifically on the nature of quantitative species-differences in Daphnides," in Falk, "Can the Norm of Reaction Save the Gene Concept?" 119.
25 Sarkar, "From the *Reaktionsnorm* to the Adaptive Norm," 235.
26 Sarkar, "From the *Reaktionsnorm* to the Adaptive Norm," 238.
27 Jonathan Harwood, "Weimar culture and biological theory," 349.
28 Jonathan Harwood, "Weimar culture and biological theory," 350.



The viability of ten different genotypes of *Drosphilia* when tested at three different temperatures. Plotted and overlaid together they visually describe the potentials held within the Norm of Reaction. Credit: Reprinted by permission of the publisher from THE TRIPLE HELIX by Richard Lewontin, p. 25, Cambridge, Mass.: Harvard University Press, Copyright © 1998 by Gius, Laterza & Figli Spa, Copyright © 2000 by the President and Fellows of Harvard College.

to the developmental process of each individual, additional phenotypic outcomes were an almost direct corollary to the degree of variability in those environmental conditions.[29] As there are potentially an infinite number of environmental factors that may interact with a given genotype, there are as many phenotypic curves (*Phänotypen-kurven)* that result if one could document all potential variables.[30] In order to effectively express the totality of the relationships embodied within an individual organism, Woltereck conceived the concept of *Reaktionsnorm* in order to describe the locus of these various phenotypic potentials. He argued that what was inherited were the NoRs themselves "as wholes"[31] and not as individual genes. Hereditary changes were thus understood as a modification of that norm and could not be localized to single gene expressions.[32] In evolutionary develop-

29 Sarkar, "From the *Reaktionsnorm* to the Adaptive Norm," 235.
30 Richard Woltereck, "Weitere experimentelle Untersuchungen uber Artveranderung, speziell uber das Wesen quantitativer Artunterschiede bei Daphnien" *Verhandlungen der deutschen zoologischen Gesellschaft* 19 (1909): 135.
31 Jonathan Harwood, "Weimar culture and biological theory," 352.
32 Sarkar, "From the *Reaktionsnorm* to the Adaptive Norm," 236.

ment what's ultimately being selected for is not a *specific reaction*, but rather the NoR's ability to produce *a range of reactions* in response to a range of conditions, its evolvability.[33] In the NoR model environmental variation is an integral *constructive* constituent of the individual phenotype and not an unavoidable nuisance to be overcome as Woltereck's contemporary Wilhelm Johannsen later portrayed.[34] Johannsen's genocentric interpretation, which lasted well up to the time of Lewontin's decisive 1974 paper, was reinforced by the pursuit of genetic determinants which sought to explain away variations derived from genotype-environment interactions.[35] These variations, although usually appearing insignificant, are often the qualities that impact the survival of the individual most profoundly, serving as the fuel for speciation and evolution. In this sense human development is not the final result of a long progression, but rather a *continuous* re-actualization within a particular local environment.

As re-presented by Lewontin the relationships expressed in the NoR have been routinely accepted, however there has been some criticism regarding its actual usefulness in the field. Although the NoR is empirically derived, it's also approximate because what's being represented often reflects only a specific environmental condition. While the definition of the "total" environment[36] is perhaps a very real necessity for the geneticist, the value of the NoR as a conceptual model for understanding development still maintains incredible potency for use by architects. Rethinking human development in this way suggests an architecture not only conceived as the functional extension of the phenotype, but through the production of *active* environmental subjectivities, capable of direct engagement it may be possible to facilitate and even direct future human development.

The architectural historian David Gissen has argued for a new conception of architecture as "producers of nature," that building technologies not only adjust spaces to the needs of particular chemical and physical metabolisms, but "they also produce conceptualizations of the natural: ideas of comfort, performance, and health…" understood as both material and discursive processes.[37] If, as Gissen claims, "all nature is laced with human agency and structure"[38] and given our understanding of the influence of local environment on evolutionary development conceived in the NoR model, then is it really so difficult to also include humans as part of the "nature" produced by architecture? What's needed in order to instigate change is the architect's conscious decision to engage with these active environmental factors as the motivators of design. This potential may certainly be observed in the effects on other species. One example cited by Reynar Banham in his text "The Environmentalist" (1962) was the *Victoria Regia* house of Chatsworh (ca. 1849), a greenhouse designed and built specifically to accommodate the most environmentally demanding species of giant water lily, the *Victoria Regia*. Through the design of "the structure of the roof, the form of the pool with its marginal shallows and central deep, and the network of four-inch heating pipes…all these combined together to create the environment in which *Victoria Regia* was to flourish as it never did elsewhere outside its native habitat."[39]

While Paxson's design mitigated the effects of the lily's transplantation from its native context by augmenting the interior space to more suitable environmental conditions, there are a variety of contemporary architects and artists working today who have extended these potentials, engaging with the human sensorium in order to produce physiological and psychological effects.[40] The Swiss architect Philippe Rahm has described his

33 The systems biologists Marc Kirschner and John Gerhart have extended Lewontin's observations, claiming that an organism's characteristics are only remotely connected to the DNA sequence through the complex processes of development, growth and metabolism. A change in DNA sequence is only indirectly correlated with change in the anatomy and physiology of the organism. These core processes are conserved precisely because they have within their mechanism the greatest ability to produce a variety of possible states in response to environmental stimuli or genetic mutations, allowing them to readily facilitate meaningful variation with only minimal direct genetic modification. John C. Gerhart and Marc Kirschner, *Plausibility of Life: Resolving Darwin's Dilemma* (New Haven: Yale University Press, 2005) 34-35.

34 Raphael Falk, "Can the Norm of Reaction Save the Gene Concept?" 123.

35 Johannsen's interpretation of Woltereck's concept of the NoR in his 1911 paper "The Genotype Conception of Heredity," *The American Naturalist* Vol. 45, No. 531 (1911): 133, regarded it as "nearly synonymous with 'genotype'" and according to Raphael Falk this interpretation ultimately "provided the framework for the conceptual isolation of the genotype as the blueprint in the vault that determines development, function, and behavior of creatures and yet is protected from any (adaptive) modification by its carriers." See: Raphael Falk, "Can the Norm of Reaction Save the Gene Concept?" 124-125.

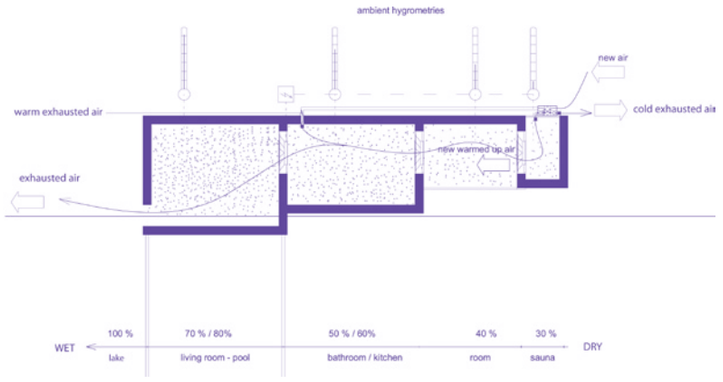
36 Total environment refers to the correspondence between environmental interactions, genomic makeup and developmental noise - the random events within cells at the scale of molecular interactions. Despite this noise being comparatively small in relationship to the whole organism, it is often responsible for producing many observable phenotypic variations amongst individuals of the same species or even between individuals of the exact same genetic makeup. See: Anurag A. Agrawal, "Phenotypic Plasticity in the Interactions and Evolution of Species," in *Science* 294 (2001): 321-326.

37 David Gissen, "APE" in *Design Ecologies: Essays on the Nature of Design* ed. by Lisa Tilder and Beth Blostein (New York: Princeton Architectural Press, 2010) 63.

38 Gissen, "APE," 64.

39 Reynar Banham, "The Environmentalist," in *Program* 2 (Spring 1962): 63.

40 One could include such diverse practices as the artist Olafur Eliasson in projects such "The Weather Project" at the Tate Modern, London (2001) and the "360 degree room for all colors" shown at the MoMA (2002), the research of David Benjamin's Living Architecture Lab, AMID (cero9)'s oxygen rehydration project for Pine Grove Park (2008), R&Sie(n)'s curtain wall system for the B_mu Tower (2005) and much of the work of Philippe Rahm and Arakawa + Gins.



Route of the air ventilation and repartition of the vapor. Design diagram Mollier Houses by Philippe Rahm Architects, (2007). Credit: Reprinted, by permission, from Philippe Rahm Architects.

approach as adopting an extreme openness towards reality, referring to "relative humidity levels, the temperature gradient, light intensity, and spectrality [as] the elements of architectural language that are called into question in producing an architectural project." This approach no longer adheres to spatial requirements as the motivation for designing architecture, but rather human physiology.[41] Rahm's design of the Mollier houses (2005) observes that various human activities both require, and result, in the presence of various levels of water vapor (relative humidity), adopting this as the major design parameter he reorganized the spaces of the house into strata, from the driest to the most humid, disregarding the traditional individualization of rooms and functions. The design doesn't program the spaces functionally, but rather according to the inhabitant's physiological needs, effectively creating new programmatic correspondences and alternative domestic possibilities.

Additionally the architect Sean Lally (Weathers) often manipulates the internal environment, leveraging physiological potentials as primary design elements, to produce new social inhabitations of space. These potentials are embedded within the architectural design through the active

41 Philippe Rahm, "In Architecture, Precisely" in *Precisions: Architecture between Sciences and the Arts,* ed. by Ākos Moravānszky and Ole W. Fischer (Berlin: Jovis Verlag, 2008) 171. An example of this would be "The Hormonorium," designed and built in collaboration with Jean-Gilles Décosterd, in the Swiss Pavilion at the Venice Biennale (2002). It recreated the environment of the "high mountains" by adjusting nitrogen levels and light intensity effectively reducing the percent of oxygen in the air to 14.5%, causing slight hypoxia, characterized by states of confusion, disorientation, and/or slight euphoria due to increased endorphin production.

mobilization of responsive sensory gradients both generated and simulated byway of advanced digital technics.[42]

The artist and architect partnership Arakawa + Gins, instigated by a perceived ethical obligation and a call to action,[43] argues for a more radical approach towards designing architecture that aspires to effect humans not laterally through physiology, but directly through continued physical engagement. Their projects are both playful and artistic; they are overtly stimulating, dealing with the body as a physical participant and demanding direct interaction through climbing, balancing, traversing and maneuvering within them. Their project *Site of Reversible Destiny – Yoro* (1993-95) is a park-like terrain of steep inclined surfaces and small pavilions that produce "nonsensical discrepancies in scale and arrangement of familiar objects and images." It strives to destabilize occupants, challenging them to keep their balance and training their bodies to become more physically and mentally agile.[44]

The design of the *Reversible Destiny* Lofts (In memory of Helen Keller) completed in Mitaka, Tokyo (2005), reorganizes the actions of body and mind within domestic spaces. The lofts are each composed of a group of separate "shape defining elements" (cube, sphere and cylinder) rotating around a sunken centralized open space that functions loosely as the kitchen. All of the interior surfaces are either painted a variety of bright colors, or are composed of various textured materials. The design of the lofts is intended to prompt inhabitants to pay closer attention to their actions and "recalibrate their equanimity and self-possession, causing them to doubt themselves long enough to find a way to reinvent themselves."[45] Similarly the design for

42 Lally's design for the SIM Residence (2006) leverages the internal environment to incorporate latent "potential energies" capable of producing a multiplicity of responses to various conditions of living. He describes these living scenarios as being instigated through "elastic and networked structures of organization (systems of display, illumination and air flow and temperature)." These systems are fully integrated into the project's ceiling design which provides the loose spatial and formal configuration of the house. It was imperative for Lally to utilize advanced softwares able to simulate and visualize the fluid dynamics of air temperature and air movement, to help provide feedback as to how these networked environmental systems behaved in relationship to various formal configurations and material properties. See: Lally, "Potential Energies," 26-29.

43 Through the development of the term "reversible destiny" Arakawa and Gins have proclaimed a war on mortality citing that any ethics that puts the preserving of life as the highest value must take a stand against death. See their book *Architectural Body*.

44 Michael Govan, *Reversible Destiny – Arakawa / Gins* (New York: Guggenheim Foundation Publications, 1997) 9.

45 "*Reversible Destiny* Lofts (In Memory of Helen Keller)," Arakawa + Gins, Reversible Destiny Foundation, (2005) accessed September 14, 2013, [http://www.reversibledestiny.org/#!reversible-destiny-lofts-mitaka-%e2%96%91%e2%96%91-in-memory-of-helen-keller]

the *Bios*cleave House (Lifespan Extending Villa), completed in East Hampton, NY (2008) is a more extreme version of the Mitaka lofts adopting the same basic organizational strategy, but manipulating the main floor surface of the house even more radically into a rolling moonscape of textured mounds. Traversing the floor to make a cup of tea or use the bathroom becomes a test of physical agility and mental focus. Slender columns become points of contact for regaining one's balance and recalibrating movement. Interior spaces flow out to the exterior around the house in various forms providing a totalizing local environment of interaction. For A+G comfort instigates stagnation and leads to mortality, they regard architecture as the greatest tool available to humans in order to subvert death. Through sentient interactions with architectural surrounds the inhabitant must remain "tentative," forcing one to continuously redefine him/herself effectively extending life indefinitely.

Although A+G's optimistic and imaginative proposition of cheating death through architectural inhabitation may be disregarded by many as fantastical aspiration, the potential to combine their participatory architectural environments of physical/mental stimulation, with the development of physiologically responsive environmental systems capable of instigating social re-compositions of inhabitation, architects might be able to fully engage with the NoR model of development. However, in order to effectively design within the dynamic space of interaction between individual development and environment posited by the NoR, architects must also utilize advanced technics able to effectively simulate and evaluate the complex relationships necessary to facilitate specific phenotypic outcomes.[46] For architects, adopting this strategy of evolvability through the design of actively engaging local architectural environments is the type of radical reorientation of priorities that may provoke actual change in humans.

46 This conceptualization of technics is similar to what the contemporary philosopher Manuel Delanda (in discussion of Deleuze and Guattari's BwO) might refer to as a "blind probe-head," a specific type of abstract machine that is the result of a sorting device coupled with the ability to replicate with variation, "or a searching device capable of exploring a space of possible forms." See Manuel Delanda, "Immanence and Transcendence in the Genesis of Form," *The South Atlantic Quarterly*, 96:3 (Summer 1997): 499-514.

View of the *Bios*cleave House (Lifespan Extending Villa) living room showing the mounded terrain of the interior floor and the stabilizing vertical poles. Designed by Arakawa + Gins, completed in East Hampton, NY (2008). Credit: ©Eric Striffler, all rights reserved.

View of the Site of Reversible Destiny parkscape showing sloped surfaces and destabilizing terrain. Designed by Arakawa + Gins (1993-95). Credit: scarletgreen, reproduced from flickr creative commons.

section five

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product

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Transgressing Limits:
Performance and the Sentient Event

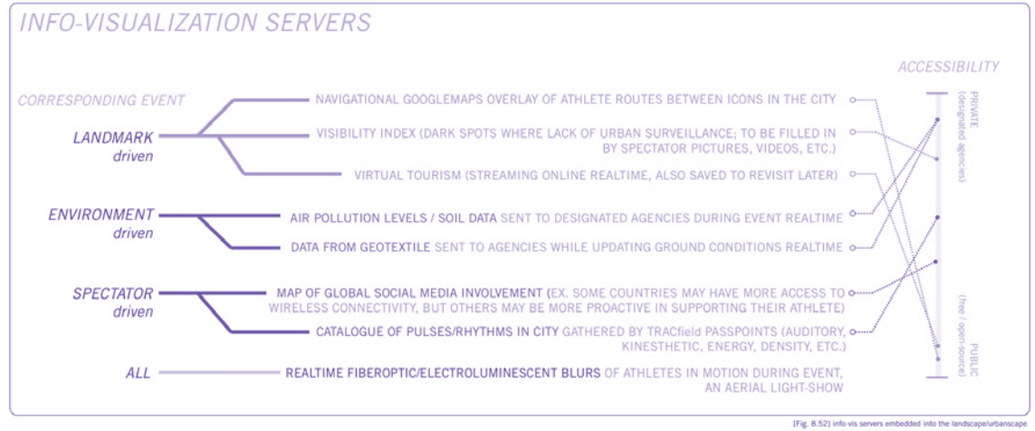
Jillian Crandall

I knew the rules of the game going into it. Be the first one to cross the finish line. But getting there... that's the challenge. As I fasten the smooth clasp on my shin guard distributor I'm reminded of why I wear them in the first place. During qualifying I was awarded a spot on my country's team and, apparently, impressed a wealthy sponsor who specializes in alternate energy. A representative from Bach Overmann claimed my "short turning radius between steps" made me well-suited to distribute the remediation spheres during the Event, so the Corporation supplied me with the latest equipment and sensor uniform. I'm talking military-grade technology. It's a part of me now. There's the top of the line dual-focus contact lens heads-up-displays, electro-pulse balance stabilizers and, of course, piezoelectric generators to power the circuitry in my suit.

One of my biggest competitors is a billionaire who spent millions of dollars on augmentations. There's hardly any flesh or blood left to him. His motivation is a need for recognition and a lust to be first at everything. There are more out there just like him—the Plutocrats. They don't scare me because they don't understand the workings of their shiny new bodies. Their goal is to exert no physical effort and have their devices run the race for them. They haven't done the training that I have—the exhaustive practicing and calibration.

In the past the Olympic committee held strict standards against performance enhancement in order to refrain from giving any unfair advantages. But now there's no even playing field. How you navigate it is all part of the game. A societal mirror. Subversive and invigorating.

Today, the games are my life—but in my opinion it took far too long for the Olympics to evolve. For decades the games had been used as leverage in cities to generate tourism and fund infrastructural developments, but too often the event left more damage in its wake than it was worth—environmentally, financially, infrastructurally. As an athlete, the biggest problem for me was the loss of challenge. The enormous increase in human capability since the early 1900s had been largely unaccounted for. Let's face it, running had come a long way from the ancients who used it to hunt and carry news of war. Even spectators began to lose interest. The public had evolved to hold high standards for entertainment and the way the Olympics used to be broadcast on TV was just not enough. The people wanted their media in new forms: in realtime—with direct involvement and connectivity.



(Fig. 8.52) info-vis servers embedded into the landscape/urbanscape

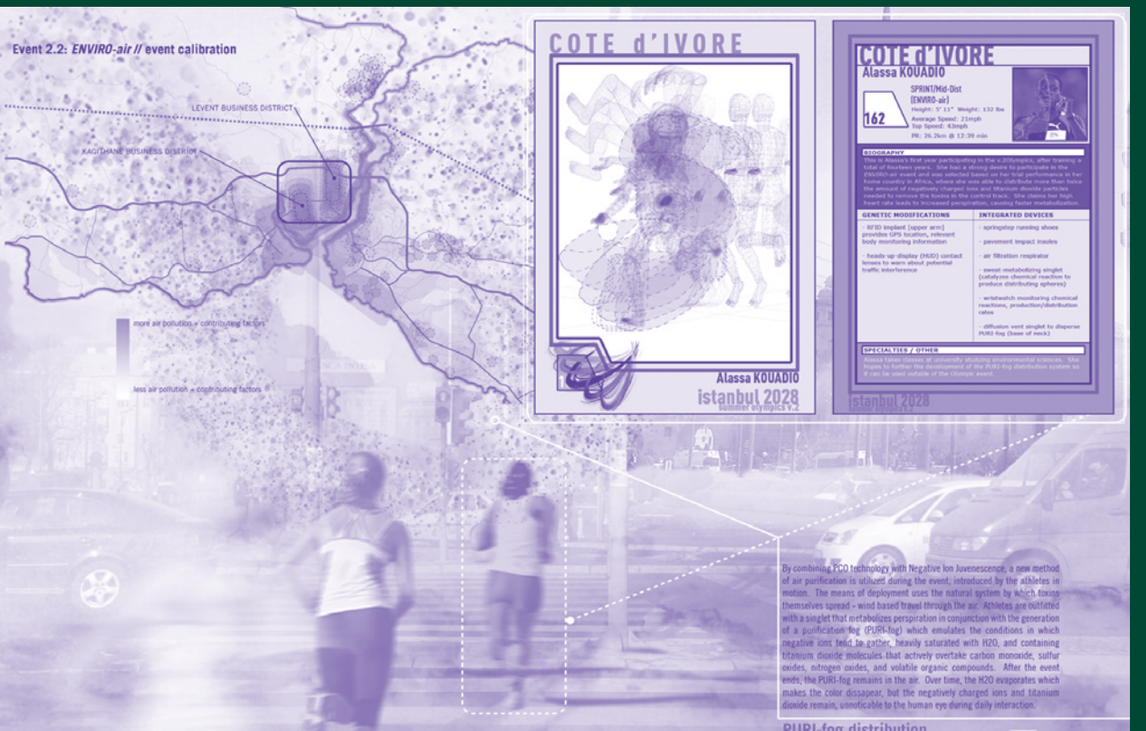
ISTANBUL PROTOTYPICAL SECT
URBAN AND ENVIRONMENTAL SYMPTOMS / TARG

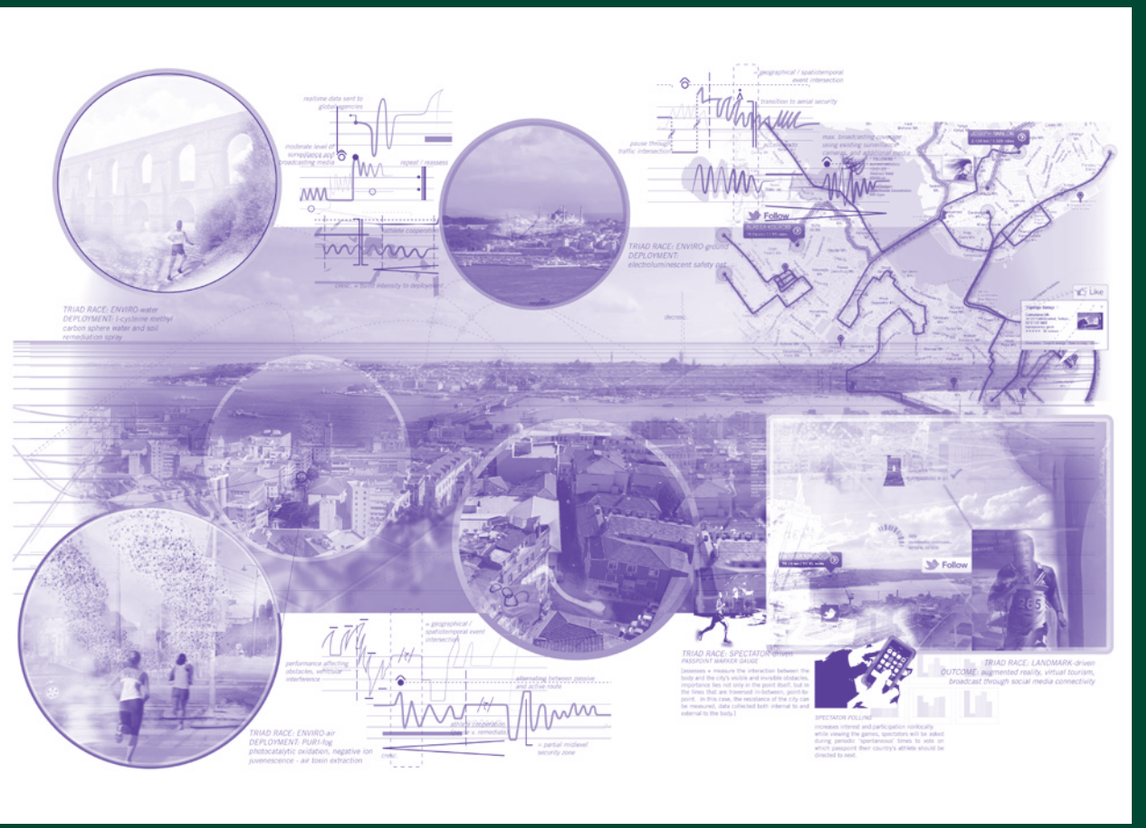
It finally became clear that the Event itself had to evolve to adapt to the spirit of the times. And so the static, stagnant, century-old version of the games was turned inside out. The walls of the stadiums were removed, letting the contents of the games bleed out into existing urban networks and infrastructure while creating a flexible, dynamic envelope shaped by physical inhabitants and nonlocal spectators. All-inclusive and interconnected.The TRACfield Triad is my event. It's an acronym for Transient Responsive Actuating Connector, and a spin on the traditional triathlon. The goal this year, determined by organizing agencies, is to create new intersections and traces in the city, via the athlete, that assess and measure the interaction between the body and the city's visible and invisible obstacles—to deploy, inform, respond, and remediate. I have to admit there's a certain rush that comes with the super-hero status of being an athlete-agent. I even have my own collectible trading card that allows fans to track my progress. Sometimes I feel like a commodity, but it's worth it.

As I warm up, I replay my last event in my head; picking apart my performance step by step. When you're in the race, everything narrows to the task at hand. It's tunnel vision, but there's input from all around: auditory, kinesthetic, visual. You have to know how to filter, read, and assess. It all comes back to me:

As I run a passive line to the next target, I draw in deep breaths of air to prepare myself. My wristwatch alerts me that my pulse rate is 168bpm and the sweat that runs down my neck collects in the fabric of my suit to metabolize into remediation spheres at a rate of—I check quickly—42%. Not bad, not great. About four meters ahead of me I see the telltale markings of another competitor through my augmented-reality lenses; footprints show where she has already distributed the carbon spheres. I match it up with the target location and realize I have a challenge cut out for me. I need to deploy at the reservoir basin, but the slope is so steep I'm unsure if I'll be able to follow the route. I reflexively make the decision to change course, my knees bracing the impact from the change in surface of sandy soil to bedrock. My shoes are indistinguishable from my feet and I can sense them actively assessing the soil; sending the data where it needs to go.

On the haze of the periphery I notice an enthusiastic group of spectators cheering from behind an invisible but effective electrified fence. I want to give them at least a nod of acknowledgement, but my focus is intractable. Right now the cleats are retracted to avoid the large stones in the path, but I have to time it exactly right if I want to be able to deploy the spores just feet away. If I don't, I run the risk of being disqualified.





Suddenly, time switches to slow-motion. That's my brain prosthesis kicking in due to the overfiring of synapses. It's a damn good thing too, because a millisecond later I would've gotten the tip of my toe caught in a hole and the Event would have been blown. Instead, I adjust the angle of my torso in respect to my hips, lifting up my calf and sticking my landing exactly where I intended. A small pleasant tingle rushes through me, and I'm unsure if I'm internally congratulating myself or if it's the electro-wiring muscle stimulation kicking into gear. I realize it was an electrolyte boost sent by a collective group of fans from my country, or so says my HUD.

Sometimes I forget the actions of the spectators have such an impact on my performance. Even though I'm a seasoned veteran of the games, I remember what it was like to be a spectator back at the Olympics v2.0 changeover. I first experienced a UNESCO sponsored event where specific routes were individually determined by the athlete but were influenced by the response of spectators across the globe. The athletes deployed the manifestation of info-visualization servers into the urbanscape, including a navigational digital-map overlay of athlete routes between icons in the city, adapted to an augmented reality. A Virtual Tourism for viewers was also created, accomplished by non-obstructive athlete-worn videocameras connected to global live-feed streaming, and GPS trackers. The Event was broadcasted aerially using existing security cameras and additional filming equipment. This defined what areas of the city were well-monitored and which were off-the-grid. In these dark areas, other spectators shared their own video, pictures, tweets, and blogs: a crowdsourced broadcast.

From over 5,000 miles away I was taken on a tour of the city through the eyes and mind of my chosen athlete (now my mentor), traveling in and around some of the most magnificent works of architecture. I voted in several Events, changing the physical course of the game to widen the track. I 'followed' a few of my other favorite athletes, and was sent realtime updates on their progress throughout the day. I tracked the games from a digital-map aerial overlay, constantly updated from fellow spectators who were live-blogging the games. There was no forced perspective here, just raw observation and sensation.

Then… a flash of brilliant silver-blue. I recognized her from my digital-map exploration earlier. My jaw dropped when I watched the lithe maneuvering of core and limb—what I could only describe as a set of beautifully graceful choreographed moves. And to think that these particles would be left in the city as a signifier of her steps, to develop, remediate, and decay over time. When I replayed the scene, it created a dizzyingly beautiful effect of ribbon dancing, an electroluminescent blur that I experienced on a visceral, aesthetic level. At that moment I decided: next year that blur would be me.

I ache with the memory, recalling how I was free to zoom out and get a sense of the whole with a safety and security that I don't get to enjoy as an athlete-agent. But there's something I'd never trade: the intoxicating sense of being put on edge, pushing beyond your own limits, never sure if you're going to make it. It's a sublime cocktail of fear and arousal coursing through your veins that lets you know you're very much alive.

There is a broader ambition to this whole production that's not readily apparent, but more and more I can see how the emerging ethos transcends the games. The Event is interwoven performance and multisensory spectacle. It occupies a space between the symbolic and the instrumental which extends to the world at large. It can be dark and transgressive, but it can be benevolent and constructive. Regardless of your role or level of participation, the Event ultimately encapsulates what it means to be human. It's in our blood and in our soil; it's our city and our homes. With it we evolve, as it evolves with us. And now it's time to fly.

"DEGREES OF FREEDOM": ON FRANK AND LILLIAN GILBRETH'S ALLOCATION OF MOVEMENT

ELLIOTT STURTEVANT

In a paper entitled "Motion Study for the Crippled Soldier," published in 1917, Frank B. and Lillian M. Gilbreth outlined a single graphical method as means of unifying the fields of time and motion study, which—under the novel heading of the "micromotion study"—had recently adopted the use of motion pictures.[1] Prior to this method, time study had sought to divide work into precisely timed motions with a stopwatch and duly trained clerk.[2] These motions however remained specific to the individual and type of work under study whether they be the operations of a particular cashier or those involved in paper-box making. These analyses, the Gilbreths quickly realized, were of little benefit in synthesizing *methods of least waste*—the ultimate aim of evaluating and combining individual motions—for these routinely performed tasks.[3]

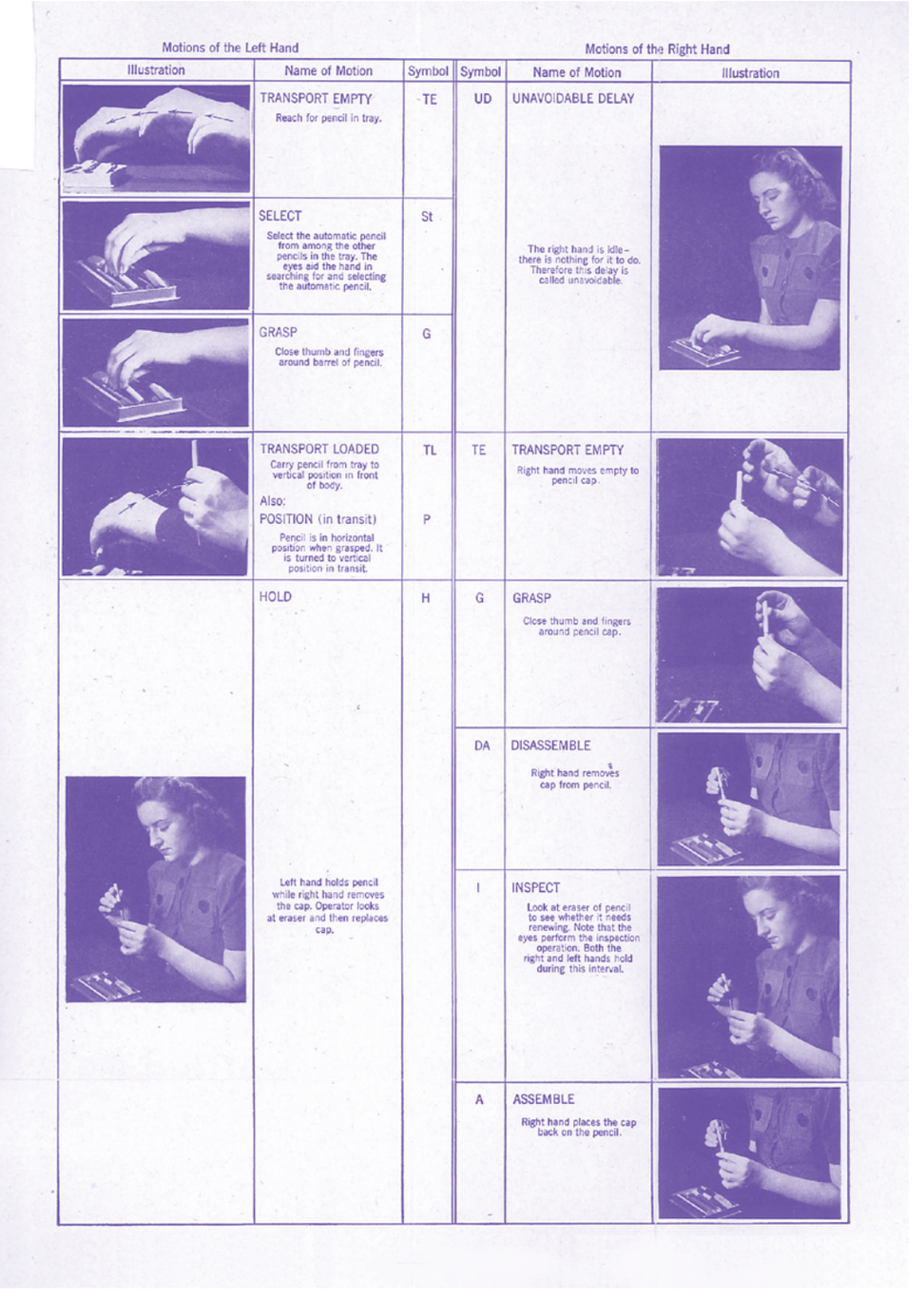
The introduction of the "Simultaneous Motion Cycle Chart" offered an alternative: the movements evidenced with the use of motion pictures would be split into a set of universal elementary motions called *therbligs*.[4] A slightly-adjusted rever-

1 For his own account of time study, see Frederick Winslow Taylor, *The Principles of Scientific Management* (New York; London: Harper & Brother, 1913); and later Steward M. Lowry, Harold B. Maynard and G. J. Stegemerten, *Time and Motion Study; and Formulas for Wage Incentives* (New York; London: McGraw-Hill, 1927). For the Gilbreths own account of the "micromotion method," see Frank B. Gilbreth and Lillian M. Gilbreth, *Applied Motion Study; A Collection of Papers on the Efficient Method to Industrial Preparedness* (New York: MacMillan, 1919). For detailed accounts of the competition and controversy surrounding Taylor and Frank Gilbreth, see Milton J. Nadworny, "Frederick Taylor and Frank Gilbreth: Competition in Scientific Management," *Business History Review* 31 (Spring 1957): 23-34; and Brian Price, "Frank and Lillian Gilbreth and the Motion Study Controversy, 1907-1930," in *A Mental Revolution: Scientific Management since Taylor*, ed. Daniel Nelson (Columbus: Ohio State University Press, 1992), 58-76.

2 For detailed accounts of the Gilbreths' use of film and their "mechanical solution to the problems of subjective vision" see, Espelth H. Brown, "Industrial Choreography: Photography and the Standardization of Motion," in *The Corporate Eye: Photography and the Rationalization of American Commercial Culture, 1884-1929* (Baltimore; London: John Hopkins University Press, 2005), 65-118; and Scott Curtis, "Images of Efficiency: The Films of Frank B. Gilbreth," in *Films that Work: Industrial Film and the Productivity of Media*, ed. Vinzenz Hediger and Patrick Vondereau (Amsterdam: Amsterdam University Press, 2009), 85-99.

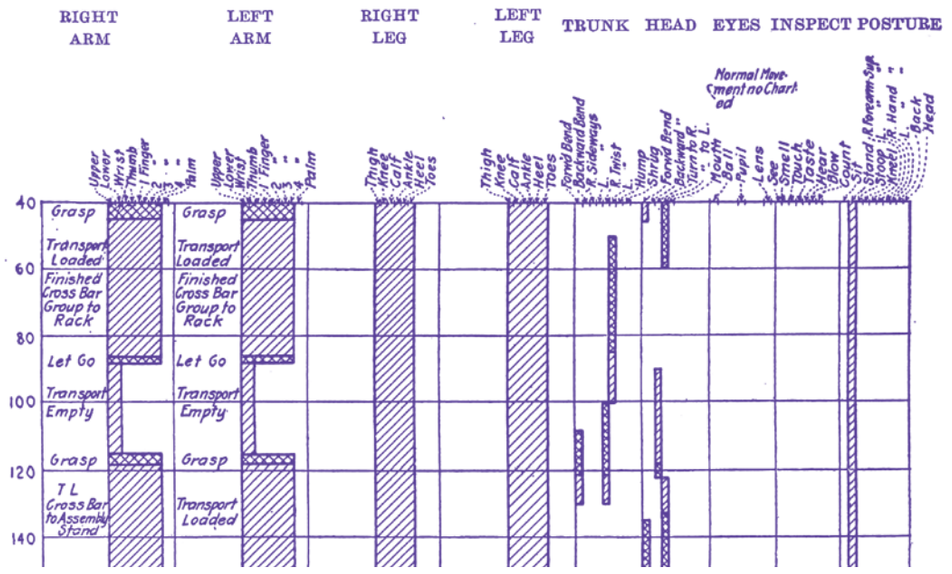
3 As the Gilbreths stated, "There is no waste of any kind in the world that equals the waste from needless, ill-directed, and ineffective motions." (Gilbreth and Gilbreth, *Applied Motion Study,* 41-56).

4 Ralph M. Barnes, *Industrial Engineering and Management, Problems and Policies*, (New York and London: McGraw-Hill Book Co., 1931), 157.



Motions of the Left Hand			Motions of the Right Hand		
Illustration	Name of Motion	Symbol	Symbol	Name of Motion	Illustration
	TRANSPORT EMPTY Reach for pencil in tray.	TE	UD	UNAVOIDABLE DELAY The right hand is idle—there is nothing for it to do. Therefore this delay is called unavoidable.	
	SELECT Select the automatic pencil from among the other pencils in the tray. The eyes aid the hand in searching for and selecting the automatic pencil.	St			
	GRASP Close thumb and fingers around barrel of pencil.	G			
	TRANSPORT LOADED Carry pencil from tray to vertical position in front of body. Also: POSITION (in transit) Pencil is in horizontal position when grasped. It is turned to vertical position in transit.	TL P	TE	TRANSPORT EMPTY Right hand moves empty to pencil cap.	
	HOLD Left hand holds pencil while right hand removes the cap. Operator looks at eraser and then replaces cap.	H	G	GRASP Close thumb and fingers around pencil cap.	
			DA	DISASSEMBLE Right hand removes cap from pencil.	
			I	INSPECT Look at eraser of pencil to see whether it needs renewing. Note that the eyes perform the inspection operation. Both the right and left hands hold during this interval.	
			A	ASSEMBLE Right hand places the cap back on the pencil.	

Example of two-handed "cycle of motions" required to remove a cap from a mechanical pencil and examine the eraser. Credit: Ralph M. Barnes. 1944, table. From: Work Methods Manual. New York: John Wiley & Sons, 1944.



Detail of the "Simultaneous Cycle Motion Chart" Credit: Frank B. & Lillian M. Gilbreth. 1919, chart. From: Applied Motion Study. New York: MacMillan, 1919.

sal of "Gilbreth," the *therbligs* represented the sixteen possible elements of a "cycle of decisions and motions." All work, the Gilbreths believed, could be represented by the following elements arranged in varying sequences: 1. Search; 2. Find; 3. Select; 4. Grasp; 5. Position; 6. Assemble; 7. Use; 8. Disassemble, or take apart; 9. Inspect; 10. Transport, loaded; 11. Pre-position for next operation; 12. Release load; 13. Transport, empty; 14. Wait (unavoidable delay); 15. Wait (avoidable delay); 16. Rest (for overcoming fatigue).[5] The chart itself was divided vertically by "anatomical groups" such as right arm and left arm, and horizontally in increments of time, typically 1/2000 of a minute, a unit which the Gilbreths called a "wink."[6] Each of the "anatomical groups" was further subdivided into subgroups such as upper arm, lower arm, wrist, thumb, first finger, second finger, third finger, fourth finger, and palm; and so on.[7] While reviewing the motion pictures, the "management engineer" allotted a *therblig* to each motion performed by an anatomical group or subgroup thereof. As such the *therbligs* became a sort of "industrial shorthand" for

5 Gilbreth and Gilbreth, *Applied Motion Study*, 138. A seventeenth *therblig*, "plan," was latter added, see Ralph M. Barnes, *"Time and Motion Study. The Motion-Picture Camera and Micromotion Study,"* in *Industrial Management and Engineering* (New York; London: McGraw-Hill, 1931), 149-180.

6 Allan Herbert Mogensen, *Common Sense Applied to Motion and Time Study*, (New York: McGraw-Hill, 1932), 87.

7 Gilbreth and Gilbreth, *Applied Motion Study*, 138-139.

analyzing the elementary motions of any particular operation.[8]

Much has been written about scientific management as the systematic standardization of work, and more specifically the rationalizing—making efficient—of industrial production.[9] Many of these studies further focus on management's nascent professionalization and its relations to labor.[10] Others have offered accounts of the effacement of the individual worker as a result of scientific management's relentless technocratic control.[11] Others still, have attempted to nuance such conceits of power by recovering subjectivity from within the managerial project.[12] But what of the understandings of subjects, systems

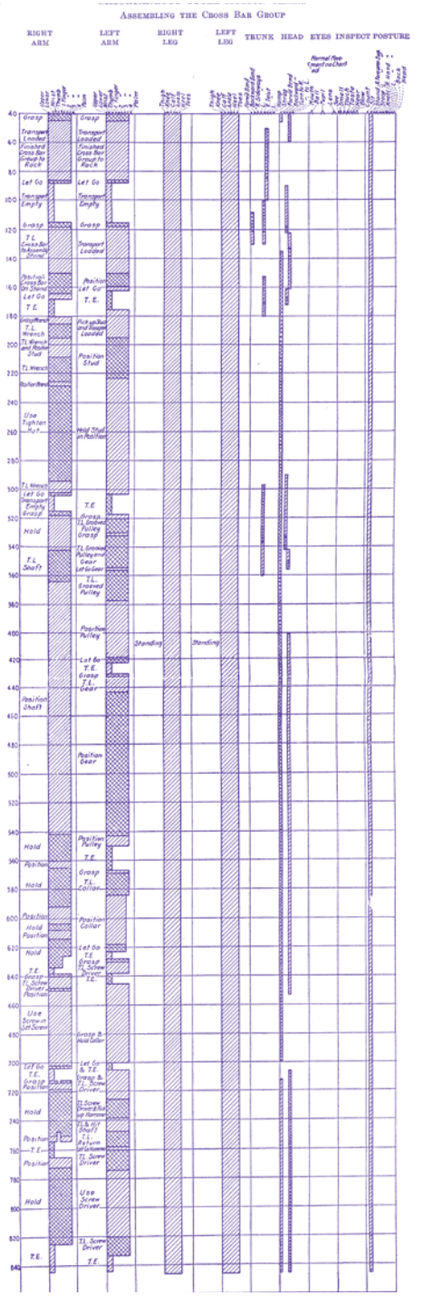
8 Mogensen, *Common Sense Applied to Motion and Time Study*, 104.

9 For seminal volumes in an overwhelming body of work, see Samuel Haber, *Efficiency and Uplift: Scientific Management in the Progressive Era, 1980-1920* (Chicago: University of Chicago Press, 1964); and Martha Banta, *Taylored Lives: Narrative Productions in the Age of Taylor, Veblen and Ford* (Berkeley; Los Angeles: University of California Press, 1993).

10 See Daniel Nelson, *Managers and Workers: Origins of the Twentieth-Century Factory System in the United States, 1880-1920*, 2nd ed. (Madison: University of Wisconsin Press, 1995), 46-51; idem, "Scientific Management, Systematic Management, and Labor, 1880-1915" *The Business History Review*, Vol, 48, No. 4 (Winter, 1974): 479-500.

11 See Richard Edwards, *Contested Terrain: the Transformation of the Workplace in the Twentieth Century* (New York: Basic Books, 1979); David Noble, *America by Design: Science, Technology and the Rise of Corporate Capitalism* (New York: Knopf, 1977); and more recently Sharon Corwin, "Picturing Efficiency: Precionism, Scientific Management, and the Effacement of Labor," *Representations* 84 (2003): 139-65; and Jennifer Karns Alexander, *The Mantra of Efficiency: From Waterwheel to Social Control* (Baltimore: John Hopkins University Press, 2008).

12 See for instance Caitjan Gainty, "'Going After the High-Brows': Frank Gilbreth and the Surgical Subject, 1912-1917," *Representations* 118, no. 1 (2012): 1-27; Richard Lindstrom, "'They All Believe They Are Undiscovered Mary Pickfords': Workers, Photography, and Scientific Management," *Technology and Culture*, Vol. 41, No. 4 (Oct., 2000): 725-751; as well as Brown, *The Corporate Eye*; and Curtis, "Images of Efficiency."



Example of the "Simultaneous Cycle Motion Chart" included in the paper. Credit: Frank B. & Lillian M. Gilbreth. 1919, chart. From: Applied Motion Study. New York: MacMillan, 1919.

and forces made visible by the simultaneous motion cycle chart? How can the chart be understood as describing forms of human subjectivity? By analyzing the worker through his or her metrically defined motions—simultaneously called upon by the "surroundings"—scientific management ultimately sought to understand work as mere movement; a fluid transaction of motion between the workers and the tools, equipment, machines and environments that surround them.

The Gilbreths' "quest for the one best way" relied on their proposal for an organizational scheme premised on the division of work by "function" rather than by "men".[13] As the Gilbreths wrote, "because the division is by men," under "traditional" or "military" management, "it is almost impossible to measure and standardize the duties of the positions."[14] Such an arrangement had traditionally sought out the most able-bodied men and had employed a strictly hierarchical understanding of authority. Character evaluation as performed by the growing field of industrial psychology had likewise been enlisted by large corporations seeking to select the best employees.[15] As an alternative the Gilbreths proposed "functional" or "scientific management," which separated acts of "planning" from "performing." The delineation of tasks "on the basis of the nature of the work that is to be done, makes possible units for measuring and standardizing the duties of the man or men who hold the positions."[16] This *standardization of duties* allowed the "planning department" to isolate individual "cycles of performance" for study—particularly motion study—but also implicitly posed a deceptively difficult question: How to establish a unit of measure?

With their industrial shorthand—the *therbligs*—now defined, the Gilbreths argued micromotion analysis was "able to work out new sequences, cycles and methods of doing any type of work."[17] The Simultaneous Motion cycle chart (the "SIMO" chart) helped identify the body members or faculties that "are doing the work," and also those that are "inefficiently occupied,

13 This phrase is used throughout their work, most notably in Lillian Moller Gilbreth, *The Quest of the One Best Way: A Sketch of the Life of Frank Gilbreth* (Easton, PA: Hive Pub. Co., 1973); for a detailed account of the Gilbreths career, see Brian Price, "One Best Way: Frank and Lillian Gilbreth's Transformation of Scientific Management, 1885-1940" (Ph.D. diss., Purdue University, 1987).

14 Gilbreth and Gilbreth, *Applied Motion* Study, 21.

15 For examples of "character analysis" see Katherine M. H. Blackford, *The Job, The Man, The Boss* (New York: Doubleday, Page & Co., 1915); and idem, *Analyzing Character: The New Science of Judging Men; Misfits in Business, The Home and Social Life* (New York: Henry Aldern Inc., 1917). For discussion of Blackford and Newcomb, and industrial psychology's ties to employment see Elspeth Brown, *The Corporate Eye*, 23-64.

16 Gilbreth and Gilbreth, *Applied Motion Study*, 24.

17 Ibid., 139.

or are available for doing parts or all of the work."[18] Existing methods were first charted using the Gilbreths' industrial shorthand, and with a view towards synthesizing a *method of least waste*, the *therbligs* were then eliminated, rearranged, or reallocated to underutilized members and faculties of the worker's body. This reinterpretation of work as a sequence of elementary motions led the Gilbreths to consider "the work to be done as a *demand* for certain motions, and the proposed worker as a *supply*."[19] Management's use of character analyses in selecting strong willed, able-bodied men was at once made irrelevant and replaced with a desire for a collection of discrete, well trained and efficiently occupied limbs.

In an effort to promote their technique, the Gilbreths suggested the use of micromotion study in adapting existing production methods to the crippled soldier by redistributing work to available limbs. In discussions following their presentation of the SIMO chart to The American Society of Mechanical Engineers, a member in attendance remarked,

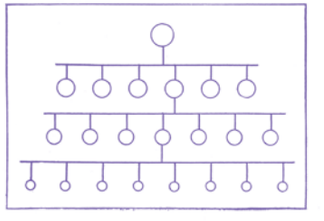
> *In many other industries, when we consider it necessary to employ able-bodied men, we are doing a great injustice to those who are crippled, and more than that, we manifest our own lack of understanding. We do not want legs for the man who is working with his brains, and vice versa for the messenger boy it is not necessary for him to have two hands. For a telegraph*

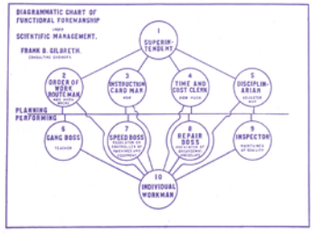
18 Ibid., 140.

19 Ibid., 135.

Name of symbol	Mnemonic symbol for Therblig	Explanation—suggested by	Color
Search		Eye turned as if searching	Black
Find		Eye straight as if fixed on object	Gray, heavy
Select		Reaching for object	Gray, light
Grasp		Hand open for grasping object	Lake red
Transport loaded		A hand with something in it	Green, heavy
Position		Object being placed by hand	Blue, heavy
Assemble		Several things put together	Violet, heavy
Use		Word "use"	Purple
Dis-assemble		One part of an assembly removed	Violet, light
Inspect		Magnifying lens	Burnt ochre
Pre-position for next cycle		A nine-pin which is set up in a bowling alley	Sky-blue, light
Release load		Dropping content out of hand	Carmine red
Transport empty		Empty hand	Green olive or light
Rest for overcoming fatigue		Man seated as if resting	Orange
Unavoidable delay		Man bumping his nose, unintentionally	Yellow ochre
Avoidable delay		Man lying down on job voluntarily	Lemon yellow
Plan		Man with his fingers at his brow, thinking	Brown

Table of the Gilbreths' *therbligs* to be used with the "Simultaneous Motion Cycle Chart." Credit: Lillian M. Gilbreth. Unknown date, table. From: Industrial Engineering and Management. London: McGraw-Hill, 1931.





Organization of authority under "traditional" or "military management vs. "functional" or "scientific" management. Credit: Frank B. & Lillian M. Gilbreth. 1919, figure. From: Applied Motion Study. New York: MacMillan, 1919.

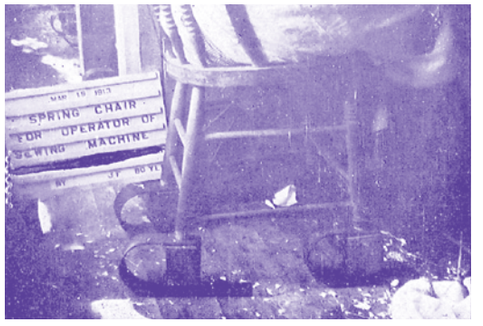
operator two arms or two hands are entirely unnecessary, and many other examples could be cited.[20]

A drastic inversion is here veiled as scientific management's assertion that the problem of efficiency is formulated as an effort to recognize work for which a man is best suited.[21] One could easily reverse this statement and suggest that work came to *demand* the movement it required in spite of the particularities and shortcomings of individual workers. The question of how to increase *supply*, a question formerly constrained by an understanding of man as machine, led the Gilbreths to pay particular attention to the exchange of motion between man and machine, or the fluidity of man-machine interaction.[22]

In a process that Georges Canguilhem would later draw upon in his definition of a "mechanism"—as that which consists of "interlinking parts" each having "a determinable degree of freedom of movement"—the *standardization of duties* required that "each piece [be] delivered to the operator in the same condition" so that he could "perform his portion of the work on each by completing a set cycle of motions."[23] The cycle of motions, in this case given by the SIMO chart, quantifies the *freedom of movement* and serves to set "limits on the amount of movement that can be expected between any two interacting solid objects."[24] Once understood as distinct, the "human element" and "materials element," including limbs, digits, postures, faculties, tools and machines, are here subsumed within a single conceptual grammar.

20 Ibid., 155.
21 Ibid., 156.
22 For discussions of the "human machine," see Richard T. Dana, *The Human Machine in Industry* (New York, Codes, 1927); and Frederic S. Lee, *The Human Machine and Industrial Efficiency* (New York; London: Longmans, Green & Co., 1919). For a seminal account of the reconstitution of the working body as a human motor, see Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (New York: Basic Books, 1990).
23 Georges Canguilhem, "Machine and Organism," in *Zone 6:* Incorporations, ed. Jonathan Crary and Sanford Kwinter (New York: Zone Books, 1992), 46; Lowry, Maynard & Stegemerten, *Time and Motion Study*, 27. On Frederick W. Taylor and motion study technicians Canguilhem writes, "If we see their aim as the elimination of all unnecessary movement and their view of output as being expressed only in terms of a certain number of mathematically determined factors, then rationalization was, for all intents and purposes, a mechanization of the body. But the realization that technically superfluous movements were biologically necessary movements was the first stumbling block to be encountered by those who insisted on viewing the problem of human-body-as-machine in exclusively technological terms. From here on, the systematic examination of certain physiological, psychotechnological and even some psychological conditions finally culminated in a reversal ... in which technology would adapt machines to the human body." ("Machine and Organism," 64).
24 Canguilhem, "Machine and Organism," 46.

Example of bin meant to facilitate "select" and "grasp" of parts. Credit: Ralph M. Barnes. 1937, image. From: Motion and Time Study. New York: John Wiley & Sons, 1937.



Spring chair "designed to eliminate fatigue from surrounding conditions." Credit: Frank B. & Lillian M Gilbreth. 1919, photograph. From: Fatigue Study. London: George Routledge and Sons, 1919.

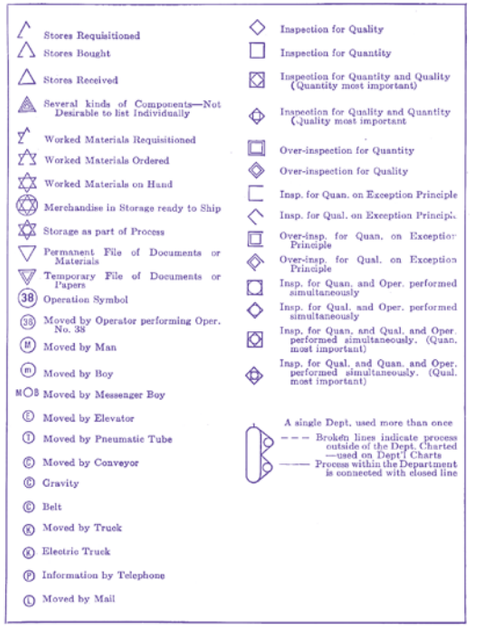
The *therblig*, made to denote individual human motion, thus became a model for the grammar of the "process chart."[25] Presented to The American Society of Mechanical Engineers four years after the introduction of the SIMO chart, the process chart allowed the management engineer to analyze, reconfigure and reallocate whole series of movements performed by combinations of man and machine. This collection of man-machine environments stressed the importance of analyzing the conditions under which motions were most efficiently made.

In an earlier publication entitled *Motion Study*, Frank Gilbreth had enumerated the variables that "make up or affect the amount of work that the worker is able to turn out."[26] The "variables of the surroundings, equipment and tools" he concluded, "differ from the variables of the worker in that we can influence them more quickly and more directly ... [they] are each and all distinctly of the present."[27] The variables included: appliances; clothes; colors; entertainment, music, reading; heating, cooling, ventilating; lighting; quality of material; reward and punishment; size of unit moved; special fatigue-eliminating devices; tools; union rules; and weight of unit moved. Scientific management's former concerns, formulated by Taylor as "defective systems of management" and "inefficient rule-of-thumb methods," are here redirected to the relationship between the workers and their surroundings. The Gilbreths' later efforts to eliminate "humanity's

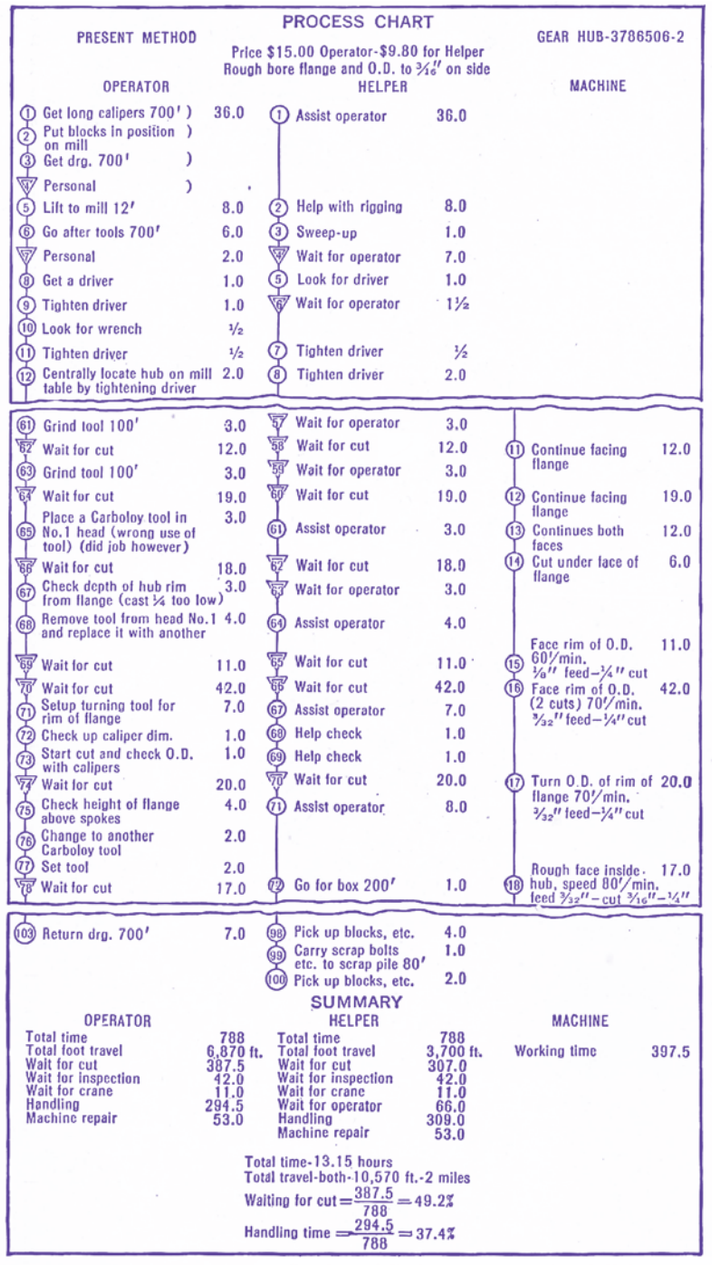
25 Frank B. Gilbreth and Lillian M. Gilbreth, "Process Charts" (paper presented at the Annual Meeting of The American Society of Mechanical Engineers, New York, New York, December 5-9, 1921).
26 Frank B. Gilbreth, *Motion Study, A Method for Increasing the Efficiency of the Workman*, (London: Constable, 1911), 6.
27 Ibid., 43.

greatest unnecessary waste," fatigue, thereby worked on the conditions effecting the most efficient exchange of required motion.[28] Disciples of Gilbreth would continue charting man-machine processes with an eye to the effects of heating, lighting, ventilation, equipment and posture as primary sites of concern.[29]

As a function of the graphical methods used to interpret them, the workers and their surroundings are brought in concert and understood as "a group of mobile parts that work together in such a way that their movement does not threaten the integrity of the unit as a whole."[30] Subsumed within a single conceptual grammar, they come together—as both *supply* and *demand*—to produce required motion and ultimately, work. Parallel to scientific management's predominant histories of efficiency, power and technocratic control, one may look to these charts and find a collection of limbs animating the managerial methods meant to efface them and ask what they suggest it is to be human.



Revised table of "Process Chart" symbols. Credit: Ralph M. Barnes. 1937, table. From: Motion and Time Study. New York: John Wiley & Sons, 1937.


PROCESS CHART

PRESENT METHOD — GEAR HUB-3786506-2

Price $15.00 Operator-$9.80 for Helper
Rough bore flange and O.D. to 3/16" on side

OPERATOR		HELPER		MACHINE	
1 Get long calipers 700')	36.0	1 Assist operator	36.0		
2 Put blocks in position) on mill					
3 Get drg. 700')					
Personal)					
5 Lift to mill 12'	8.0	2 Help with rigging	8.0		
6 Go after tools 700'	6.0	3 Sweep-up	1.0		
Personal	2.0	Wait for operator	7.0		
8 Get a driver	1.0	5 Look for driver	1.0		
9 Tighten driver	1.0	Wait for operator	1½		
10 Look for wrench	½				
11 Tighten driver	½	7 Tighten driver	½		
12 Centrally locate hub on mill table by tightening driver	2.0	8 Tighten driver	2.0		
61 Grind tool 100'	3.0	Wait for operator	3.0		
62 Wait for cut	12.0	58 Wait for cut	12.0	11 Continue facing flange	12.0
63 Grind tool 100'	3.0	Wait for operator	3.0		
64 Wait for cut	19.0	60 Wait for cut	19.0	12 Continue facing flange	19.0
65 Place a Carboloy tool in No.1 head (wrong use of tool) (did job however)	3.0	61 Assist operator	3.0	13 Continues both faces	12.0
66 Wait for cut	18.0	62 Wait for cut	18.0	14 Cut under face of flange	6.0
67 Check depth of hub rim from flange (cast ¼ too low)	3.0	63 Wait for operator	3.0		
68 Remove tool from head No.1 and replace it with another	4.0	64 Assist operator	4.0		
69 Wait for cut	11.0	65 Wait for cut	11.0	15 Face rim of O.D. 60'/min. 1/8" feed–¼" cut	11.0
70 Wait for cut	42.0	66 Wait for cut	42.0	16 Face rim of O.D. (2 cuts) 70'/min. 3/32" feed–¼" cut	42.0
71 Setup turning tool for rim of flange	7.0	67 Assist operator	7.0		
72 Check up caliper dim.	1.0	68 Help check	1.0		
73 Start cut and check O.D. with calipers	1.0	69 Help check	1.0		
74 Wait for cut	20.0	70 Wait for cut	20.0	17 Turn O.D. of rim of flange 70'/min. 3/32" feed–¼" cut	20.0
75 Check height of flange above spokes	4.0	71 Assist operator	8.0		
76 Change to another Carboloy tool	2.0				
77 Set tool	2.0				
78 Wait for cut	17.0	72 Go for box 200'	1.0	18 Rough face inside hub, speed 80'/min. feed 3/32"–cut 3/16"–¼"	17.0
103 Return drg. 700'	7.0	98 Pick up blocks, etc.	4.0		
		99 Carry scrap bolts etc. to scrap pile 80'	1.0		
		100 Pick up blocks, etc.	2.0		

SUMMARY

OPERATOR		HELPER		MACHINE	
Total time	788	Total time	788		
Total foot travel	6,870 ft.	Total foot travel	3,700 ft.	Working time	397.5
Wait for cut	387.5	Wait for cut	307.0		
Wait for inspection	42.0	Wait for inspection	42.0		
Wait for crane	11.0	Wait for crane	11.0		
Handling	294.5	Wait for operator	66.0		
Machine repair	53.0	Handling	309.0		
		Machine repair	53.0		

Total time-13.15 hours
Total travel-both-10,570 ft.-2 miles

Waiting for cut $= \frac{387.5}{788} = 49.2\%$

Handling time $= \frac{294.5}{788} = 37.4\%$

Example of "Man-and-machine process chart." Credit: Ralph M. Barnes. 1937, chart. From: Motion and Time Study. New York: John Wiley & Sons, 1937.

28 See Frank B. Gilbreth and Lillian M. Gilbreth, *Fatigue Study: The Elimination of Humanity's Greatest Unnecessary Waste, A First Step in Motion* (New York: Macmillan, 1919).

29 Ralph M. Barnes, *Motion and Time Study*, (New York; London: J. Wiley & Sons, 1937), 2; Barnes; *Industrial Engineering and Management*; Mogensen; *Common Sense Applied to Motion and Time Study*; and Marvin E. Mundel *Motion and Time Study: Principles and Practice* (New York: Prentice-Hall, 1950).

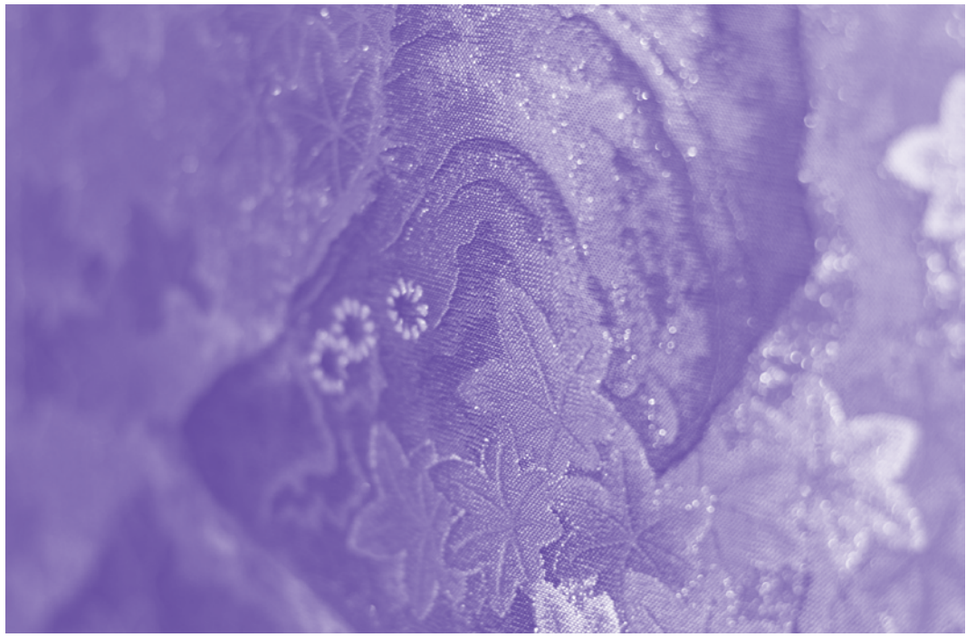
30 Canguilhem, "Machine and Organism," 46.

THE SPIRIT IN THE MACHINE: MUTUAL AFFINITIES BETWEEN HUMANS AND MACHINES IN JAPANESE TEXTILES

JENNY HALL

Artisans who make traditional Japanese handmade products often claim that they are creating themselves through their work. Many believe that something of themselves, often termed *kokoro* (translated loosely as heart, mind or spirit) in Japanese, is embodied in the final product sold to the consumer and promoted as a point of differentiation from mass-produced items. At first this claim may appear credible—since the Arts and Crafts Movement of the 19th century, similar arguments have been made regarding handcrafted items. However, a close look at the production techniques of these Japanese products reveals that the creation of a "self" is not so discrete. The division of labor, which characterizes traditional crafts in Japan, means that a different specialist completes each step. Despite this division, not all specialists are deemed equal by consumers, so how is it possible to know whose spirit is embodied within the finished product? Artisans today also increasingly use tools and machines, which are seen to complicate this transition of the "self" to the product. Machines not only blur the concept of what it means to be handmade, but they have long been associated with techniques of mass-production that often indicate a divorce of the artisan or laborer from the items they produce. As early as 1853 Victorian era art critic, John Ruskin, wrote that "You must either make a tool of the creature, or a man of him. You cannot make both."[1] Ruskin believed that automation rendered objects soulless because of their precision, leaving nothing of the character bestowed by human folly and individuality that makes a handmade object unique. Japanese artisans also believe in the unique characteristics, or *kosei,* of handmade items. However, Japanese artisans claim that, rather than producing soulless objects, the tools and machines become a spiritual extension of themselves, thereby acting as a conduit for their *kokoro*. This essay explains why this belief of the spirit in the machine is prevalent in Japanese culture through an examination of Japanese traditional textiles, and how it is this that sets them apart from mass-produced items.

1 John Ruskin, *The Stones of Venice, Volume the Second: The Sea-stories*, (London: Smith, Elder & Co., 1853) eBook edition #30755 released 31 Dec 2009.



A *maru-obi* from the Nishijin Ori Kôgei Bijutsukan, Kyoto, September 2012.

The relationship between human beings and machines in Japanese heritage industries can be explained through two interrelated concepts. The first is the idea of technology as an extension of the human body. The second is the belief that the human spirit can be embodied within technology. Both of these concepts convey the idea that the end product somehow embodies the spirit of the artisan. In order to understand how artisans conceive of these processes, it is first necessary to explore traditional methods of learning crafts in Japan, a method that involves mimicry and repetition until the actions are embodied. I employ an ethnographic approach in order to provide an insight into emic concepts of technology and the human body allowing us to understand the relationship between artisans and their machines more clearly. The research is based on ethnographic data collected through participant-observation fieldwork on the heritage textile industry of Kyoto, in particular the textile crafts that make up the bulk of that industry. Fieldwork took place from February to April 2010 and from September to November 2012. This essay first provides an introduction to the field site followed by a more detailed description of weaving. Following that is an explanation of traditional Japanese ways of learning crafts (such as weaving) and the effect of this on spiritual transmission.

Finally I discuss Japanese ways of thinking about the body and why this justifies Japanese artisan's claims that they are creating themselves through their products.

Textiles play a vital role in the traditional culture of Japan—and textile artisans form the bulk of the traditional artisans working in Kyoto today.[2] A main part of the traditional textile industry in Kyoto is *Nishijin-ori*—woven textiles associated with the district of Nishijin in the northwest of the city. Originally, as with many traditional Japanese arts, the stages of textile production were separate, each step performed by a specialist. It was unusual for one company to complete all aspects in the production process. This is still true to a certain extent today, and the companies that specialize in weaving will outsource specialist skills such as pattern design, blueprint charts and thread dyeing.

Weaving provides an ideal example of the symbiotic relationship created between human and machine. On a treadle loom[3] the weaver controls the warp threads using foot pedals,

A treadle loom with foot pedals, Tatsumura Kôhô's workshop, Kyoto, October 2012.

A jacquard mechanism attached to a treadle loom, Tatsumura Kôhô's workshop, Kyoto, October 2012.

2 *KIC Report 2009,* Kyoto Foreign Investment Promotion Committee, http://www.kic-kyoto.jp/ (accessed 21/06/2012).

3 In Kyoto there are four main types of looms in use in the kimono industry today: the treadle loom (a more traditional loom with no automation), the jacquard (a semi-automated system where a punchcard controls the warp threads), the power loom (which uses a power source to drive mechanical parts) and the digital loom (computerised control of the warp and weft).

while threading the weft across the fabric by passing the shuttle hand-to-hand. The wooden loom works as an extension of the body, and the weaver develops a kind of rhythm, beating the warp threads tightly after each slide of the shuttle. The pace is slow and often interrupted by necessary adjustments and alterations such as rethreading the shuttle or pulling the completed fabric through, but the repetitive actions become so embodied that, as Kenneth Kensinger wrote about a Peruvian Cashinahua weaver, "her hands know" because "they are the conduit by which the knowledge entered the body."[4]

Today, Kyoto weavers, who are using handlooms such as the treadle loom, might also use a jacquard (*jakâdo* in Japanese), which is an attachment that can be added to a handloom or a power loom to control the warp threads. The jacquard means that a weaver does not have to remember the entire sequence of treadlings that make up a pattern, or keep track of where they are in the sequence—the jacquard does this for them. However, as with treadle loom weaving, labor is divided between a number of specialists: the sketcher who draws the design, the blueprint chart specialist who transfers the design to a piece of graph paper, a specialist who translates the blueprint chart into holes in the jacquard board, the yarn dyers, the loom stringers, and last but not least, the weaver[s]. One might assume that this division of labor would render the relationship of each specialist to the product is attenuated and that therefore the connection between specialist and product would be almost negligible. However, as anthropologist Dorinne Kondo points out regarding Japanese artisans:

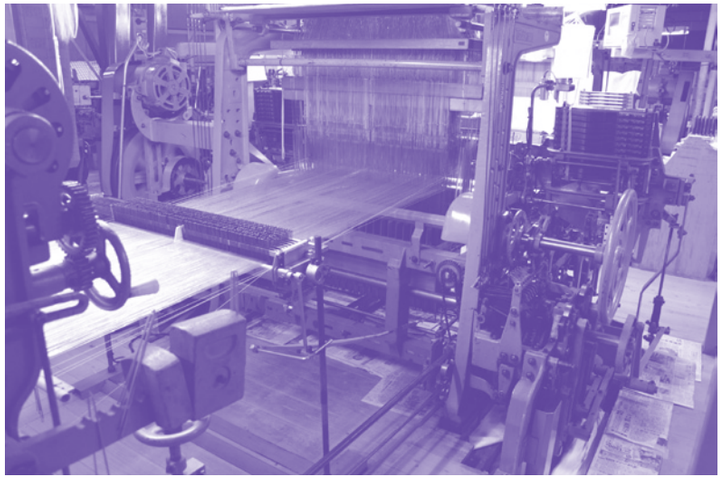
> *The penchant for humanizing the machine implies that human beings and machines partake of the same world, and that people are intimately identified with the process of production, for the very machines they use in creating their products—even if the product is made on an assembly line—can be thought of as parts of themselves.*[5]

Assembly-line production in the textile industry came with the introduction of the power loom in the late 17th century and had a tremendous impact on weavers, both in terms of speed of production and work environment. Production processes such as manually feeding the shuttle back and forth became mechanized, driven by a power source. Prior to its introduction, weavers could work at their own pace and rhythm, with the clacking

4 Kenneth Kensinger, "A body of knowledge, or the body knows", *Expedition* 33, no.3 (1991), 40–41.

5 Dorinne Kondo, *Crafting selves: power, gender and discourses of identity in a Japanese workplace*, (Chicago: The University of Chicago Press, 1990), 246.

of the wooden looms as their soundscape. With the advent of the power loom, the pressure to keep up with the machine's pace, the intense noise it produced and the smell of the oiled machine was markedly different. Third generation Nishijin-based *obi* (kimono sash) manufacturer, Tanaka Shinichi, told me that the weavers get used to the noise and that babies who grow up having been surrounded by the noise while in the womb only cry when the looms stop.[6] These technological changes are important because they become embodied in the artisans' ways of working. They become part of a relationship of "mutual affinity"[7] connecting human and machine, creating "cultural narratives of intimacy."[8]



Hosoi's digital loom at the Nishijin Ori Kôgei Bijutsukan, Kyoto, September 2012.

At the Nishijin Ori Kôgei Bijutsukan factory, weaver Hosoi uses a digital loom to weave *maru-obi* (a double-sided kimono sash).

The multiple shuttles are operated by a power source and the jacquard is computerized. She has been a weaver for 49 years, and noted some of the changes during that time,

> *The busiest period was about 30 years ago, during the bubble economy. Now the neighbourhood is quiet compared to then—Nishijin was noisy with the sound of weaving machines. The machine is so noisy! My hearing has become worse because of it. All of the weavers using these machines have bad hearing and suffer from hearing loss.*[9]

Hosoi is on her feet all day, overseeing the functioning of the machine, the noise of which rarely pauses during work hours. She complained about the conditions but still recognizes the quality of the products she produces, stating,

> *The machine drips oil on me, staining my clothes so it is dirty work and I do not get to wear the beautiful things that I make. The women at the gallery [that displays her goods] are wearing beautiful kimono, aren't they? But I don't have a chance to wear them.*[10]

Hosoi and the machine are connected in the creation of these high quality products, and even if she does not acknowledge that the machine is an extension of herself, the company makes reference to it by displaying an older treadle loom in her workshop.

Old treadle loom in the Nishijin Ori Kôgei Bijutsukan workshop, Kyoto, September 2012.

6 Tanaka Shinichi, pers. comm., 1 Nov 2012.
7 Dorinne Kondo, "Polishing your heart: artisans and machines in Japan", in *The book of touch*, ed. Constance Classen (Oxford: Berg, 2005), 409.
8 Hirofumi Katsuno, "The robot's heart: tinkering with humanity and intimacy in robot-building," *Japanese Studies* 31, no.1 (2011), 93.
9 Mrs Hosoi, pers. comm., 26 Sep 2012.
10 Ibid.

This (consciously or unconsciously) invokes "the legacy of the craftsman, seen as creating himself in his products,"[11] by linking Hosoi to the handmade nature of the product. Hosoi knows the idiosyncrasies of the loom like those of an old friend, and her bodily dialogue with it means she knows how to coax the best from it. In addition, Nishijin Ori Kôgei Bijutsukan gallery customers are encouraged to walk up the street to the factory to see Hosoi work, thereby re-enforcing the intimate connection between weaver, machine and product. It is this connection that is vital to the Japanese idea "held by artisans and customers alike" that products embody the spirit of the artisan.

One way of explaining why heritage industries are able to evoke *kokoro* in their products concerns the method of passing on artistic skills such as weaving in Japan. The master passes on tacit knowledge through *kata*, patterned formulas, which the trainee learns through mimicry and repetition. This is done in order to "fuse the individual to the form so that the individual becomes the form and the form becomes the individual."[12] While it is important to adhere to particular *kata*, once techniques have been mastered to the extent suggested above, the skill and depth of knowledge enables the artist/singer/performer the ability to introduce elements of individual style and produce something that has *kosei,* allowing their own spirit to enter the work and create an intimacy between themselves, their machine and the final product. For weaving, one such unique characteristic is what third-generation weaver Tatsumura Kôhô describes as "visual-textural", claiming that it's possible to distinguish subtle changes in the same types of cloth that have been woven by different weavers.[13]

Kata are not necessarily consciously learned in order for them to be internalized, as second-generation kimono designer Kawabe Yûnosuke's comment confirms, "I might not understand the meaning behind the actions but I can do it."[14] Repetition is the key to embodying the master's knowledge, as "[w]orking on the external through *kata* transforms and defines the internal."[15] So *kata* are important because they are believed to alter the spirit of the artisan. In addition, through this degree of internalization, *kata* carry forward the spiritual essence of a person even inter-generationally as "the teacher's *kata*, too, replicates his teacher before him, making any present-day execution of *kata* a living presence of what has come before."[16] Therefore it is possible for an artisan to claim not just their own spirit but also their teacher's as being embodied in an object. In addition, these learned actions have an impact on the artisan's body, sensory implications that create a feedback loop which engages the artisan and their tools/materials/machine in an ever-evolving relationship that in turn affects the resulting products and the spirit embodied.

Another reason that artisans can evoke spirit is that Japanese concepts of the human body are flexible enough to encompass technology as an extension of the body. Japanese philosopher Ichikawa Hiroshi,[17] addressed questions regarding technology as an extension of the human body in his 1975 book *Seishin toshite no shitai* [The Body as Spirit]. [18] He argued that "the spread of the lived body extends beyond the physical, objectified body, and it is always varying."[19] Of course these ideas are not new to Western discourse: Marshall McLuhan defined technology as any extension of the human body, which includes books as extensions of the eyes, the wheel as an extension of the foot, clothes as an extension of the skin, and electronic communications as extensions of the central nervous system.[20] In the same vein, Donna Haraway asked "why should our bodies end at the skin?"[21] Ichikawa proposed three types of body-space to explain the experiential state of the body: innate body-space (*seito-kuteki shintai kûkan*), which roughly corresponds to the skin; semi-definite body-space (*junkoseiteki shintai kûkan*) mediated through the use of tools—for example a tool becomes an extension of the hand, and with practice can be internalized within the body to become "second nature" as it is mastered; and indefinitely varying body-space (*fukakuteiki na kahenteki shintai kûkan*) that is non-habitual and constantly changing.[22]

11 Dorinne Kondo, Crafting selves: power, gender and discourses of identity in a Japanese workplace, (Chicago: The University of Chicago Press, 1990), 245.
12 Christine Yano, *Tears of Longing: Nostalgia and the Nation in Japanese Popular Song*, (Cambridge: Harvard University Press, 2002), 26. Yano is discussing the popular Japanese music genre, *enka*, here but it is just as pertinent to other art forms, including weaving.
13 Tatsumura Kôhô, "Nishiki." Accessed Nov 25, 2013 http://www.koho-nishiki.com/en/about/
14 Kawabe Yûnosuke, pers. comm., 9 Oct 2012.
15 Christine Yano, 26.
16 Christine Yano, *Tears of Longing: Nostalgia and the Nation in Japanese Popular Song*, (Cambridge: Harvard University Press, 2002), 195.
17 I have used the East Asian convention of family name, first name throughout, including references. Exceptions to this are American scholars that have Japanese names.
18 Cited in Nagatomo Shigenori, "Ichikawa's View of the Body," *Philosophy East and West* 36, no. 4 (1986), 375–391.
19 Ibid, 377.
20 Marshall McLuhan, *The Medium is the Massage: an inventory of effects*, (New York: Bantam Books 1967).
21 Donna Haraway, *Simians, Cyborgs and Women*, (London: Free Association Books, 1991), 178.
22 Ibid.

In the Japanese psyche, the boundary between humans and inanimate objects is not clear-cut in regard to the body, and tools are often seen as extensions of the body—the semi-definite body-space that Ichikawa described above.

This semi-definite body-space idea can be found in research regarding other industries in Japan. For example, Matthews Hamabata found that for workers in a Japanese brewery, "machines were extensions of themselves as spiritual beings, as creators of things, things of high quality".[23] He goes on to explain that the workers maintain that when they "polish their machines, they are also polishing their own hearts" (*kikai o migakeba, kokoro mo migakimasu*). The machines are extensions of themselves as producers. This can be applied across industries, so that a brush is an extension of the hand, or the pedal on a treadle loom is an extension of the leg. We can even view Hosoi's digital loom as an extension of her body. Conversely, human body parts can also be perceived as tools in Japanese weaving. For example, *tsuzure-ori* is a particular form of Japanese tapestry weaving done solely by hand. Some *tsuzure* weavers file serrated edges into their fingernails to aid in the weaving, creating their own tool with their nails. This demonstrates that not only are boundaries between body and machine blurred, but that the relationship is not viewed as a being in one direction. In addition, Hosoi's comments regarding the loom's affects on her body are important because they demonstrate that the interaction between human and machine is not a one-way process. According to Ishikawa, an act of perception (visual or tactile) extends into the object perceived and during this process there is a "bodily dialogue" (*shintaiteki taiwa*) with the object. Brenda Farnell's analysis of kinesthesia whereby our own actions contribute to a world that is continually coming into being rendering us "dynamically embodied" [24] supports this argument that humans and objects are intertwined in this hermeneutic circle of interaction. The impact of the machine on Hosoi's body in turn changes her interaction with it creating the "bodily dialogue" Ichikawa refers to as part of his third type of body space. Therefore each product will be imbued with a different version of her spirit or heart in a constantly evolving process.

The idea that the tool, or the end product created by the human and tool, contains part of the artisan's spirit or "heart" may have originated in Shinto beliefs since *kami* (gods) express themselves as both animate objects like trees and animals, as well as inanimate objects such as tools and everyday artifacts. However, it is more likely that it came from the "intimate or intensely personal ways in which men and women used such implements year after year…[which] led people to consider the objects as extensions of their own life or their own soul".[25] The idea of *kokoro,* a popular trope in Japanese robot culture, is ubiquitous in other sections of Japanese culture and is common in the arts, a point confirmed by fieldwork interviews. Kimono designer Kimura expressed it in these terms: "if you feel you are enjoying yourself, then your design will show that, if you are tired, that will also show in your design."[26] Apparel maker Kameda Kazuaki, who uses traditional *kata-yûzen* (stencil-dyeing) techniques to produce men's silk shirts and women's clothing, states that "Each of our unique patterns has its own 'heart' which must be expressed in the final product."[27] Spirit, or heart, are commonly evoked when marketing heritage industry products to consumers as a point of differentiation from mass-produced items.

Gradually textile production processes in Kyoto are changing, moving to newer forms of technology such as the digital loom employed by Hosoi. As explained above, the belief that these looms still embody part of the artisan's spirit, and pass that spirit on to the final product, prevails among artisans and Japanese consumers. However, in a new form of textile production, that of digital-*yûzen*, this is not the case. Traditionally *yûzen* is a form of dyeing fabric, using paste-resist to block certain parts of the fabric and prevent it from being dyed. Young Japanese designers[28] are now able to create *yûzen*-style patterns for kimono on computer and

23 Matthews Hamabata cited in Dorinne Kondo, "Polishing your heart: artisans and machines in Japan", in *The book of touch*, ed. Constance Classen (Oxford: Berg, 2005), 410.

24 Brenda Farnell, "Kinesthetic sense and dynamically embodied action," *Journal for the Anthropological Study of Human Movement*, 12(4), 134.

25 Elizabeth Lillehoj, "Transfigurations: Man-Made Objects as Demons in Japanese Scrolls," *Asian Folklore Studies*, Vol. 54, No. 1 (1995), 24–7. These kinds of beliefs date at least as far back as the medieval period and are still prevalent today, as Katsuno Hirofumi found in his research into humanoid robots, where robot builders and audience members come to 'feel the heart in the robot'. Katsuno Hirofumi, "The robot's heart: tinkering with humanity and intimacy in robot-building," *Japanese Studies* 31, no.1 (2011), 94.

26 Kimura, pers. comm., 19 Oct 2012.

27 Pagong "Products and Yuzen." Accessed Nov 25, 2013 http://www.pagong.jp/en/products-yuzen/.

28 I have used the word "young" here to denote those under 45 years old. The majority of traditional artisans are older than this and do not employ digital-*yûzen* methods. For example, the average age of weavers Tanaka Shinichi (mentioned above) employs are between 60 to 70 years old (Tanaka Shinichi, pers. comm., 1 Nov 2012).

print these patterns out directly onto the cloth with the use of an inkjet printer thereby eliminating the skills of at least four specialists in the process. As a result of this streamlined process a digital-*yûzen* artisan can claim sole attribution for their designs, but ironically this does not lead to them claiming that the final product is an embodiment of their spirit. Two factors appear to influence this. First, whereas artisans using traditional techniques see each of their final products as having *kosei* (unique characteristics) because they cannot be exactly reproduced, Mori Makoto, a digital-*yûzen* designer, sees exact replication as a positive feature of his process. And second, the printer operates by itself with little contact from Mori, and perhaps it is this separation, creating a gap between human and machine that results in a lack of affinity between them. As Mori notes, his workspace is very similar to a contemporary office, with computers and the constant whir of the inkjet printer in the corner. Mori recognizes this lack of affinity, stating, "Of course I can print a really complicated design but even if I can do the same design and colours as those done using *kata yûzen* or *tegaki yûzen*,[29] I can't replicate a deep feeling."[30]

With this essay I have shown that Japanese concepts of the human body conceive of technology as an extension of the body through Ishikawa's idea of a semi-definite body-space within which humans and tools/machines interact to create a final product. This final product is in turn viewed as an embodiment of the creator. Many Japanese artisans believe that their *kokoro* is conveyed in the objects they make. This concept is akin to French sociologist Jean Baudrillard's idea that objects in general "take on a certain density, an emotional value—what might be called a 'presence.'" [31] In exploring the relationship between human beings and machines through the work of Japanese artisans, it appears that the hands of the maker—having had contact with the product, either directly or through a machine, is somehow important for the transmission of the maker's essence or spirit. In Japan this transmission is intricately linked to *kata*, and it is this that allows the artisan to develop a mutual affinity with their tools in order to create *kosei*, evoking intimacy in their products. And while Mori is able to create unique kimono, it is obvious that *kokoro* is not transmitted in the same way as traditional methods, thus providing an argument for the preservation of traditional industries.

29 *Kata yûzen* is stencil *yûzen* and *tegaki yûzen* is handpainted *yûzen*.
30 Mori Makoto, pers. comm., 21 Sep 2012.
31 Jean Baudrillard, (trans James Benedict), *The System of Objects* (London: Verso, 1996), 16.

Mori Makoto's workplace (Mori is on the left in the photo), Kyoto, September 2012.

Kimono fabric made by Mori Makoto using a computer and inkjet printer, Kyoto, September 2012.

An example of traditional *yûzen* before the paste-resist has been washed off by Saeki Toshiaki, Kyoto, November 2012.

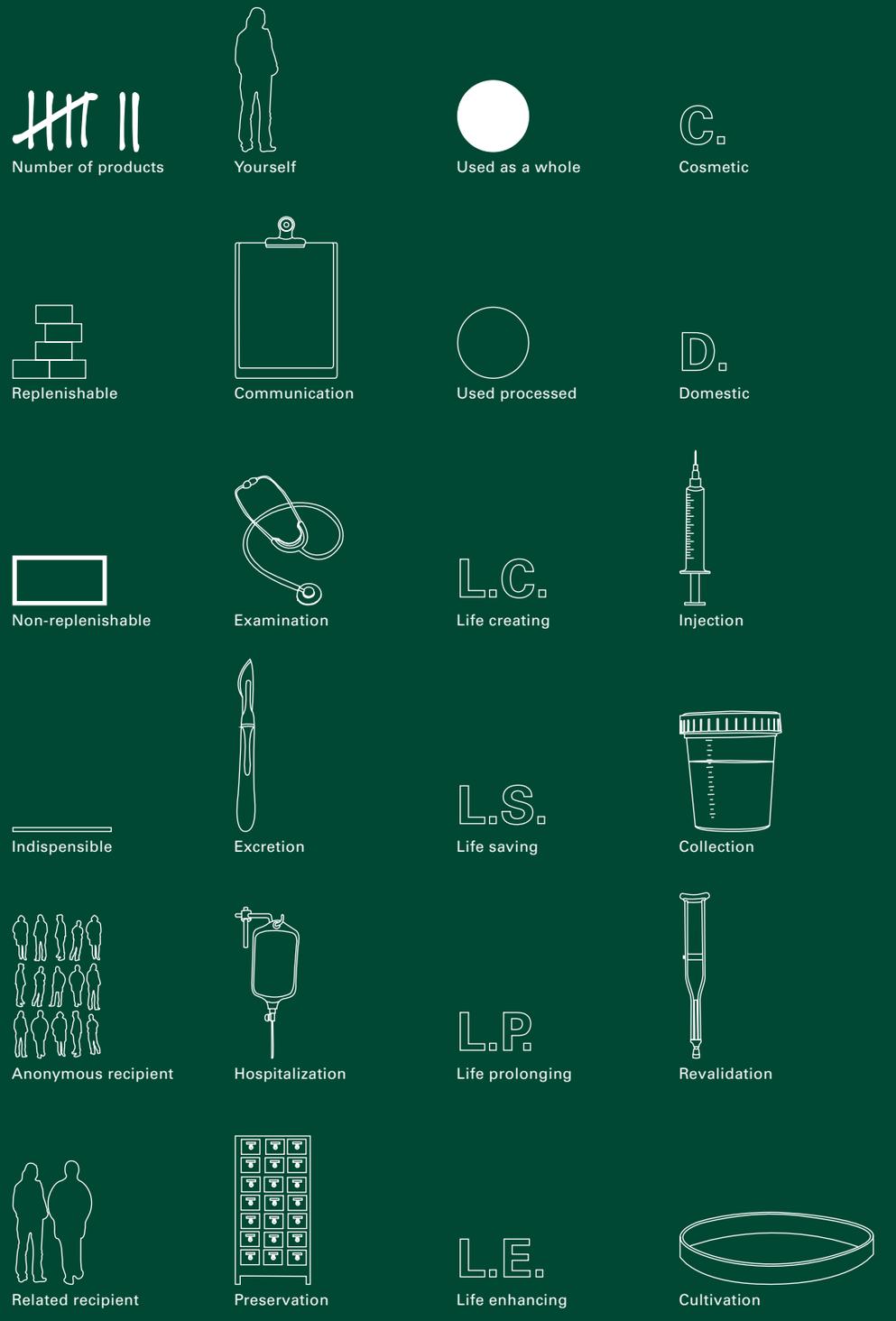
Corpus Commodus:
A guideline through the physical reality of the living human body as a commodity

Alissa van Asseldonk

Corpus Commodus is a documentation of present possibilities in harvesting, processing, and using human tissue and how these activities manifest within the world. This book uses a visual language to make its information accessible to a broader public. In an objective, almost clinical way, Corpus Commodus visualizes and maps the applications of tissues that are either donated, remain after surgery, or secreted on a regular basis.

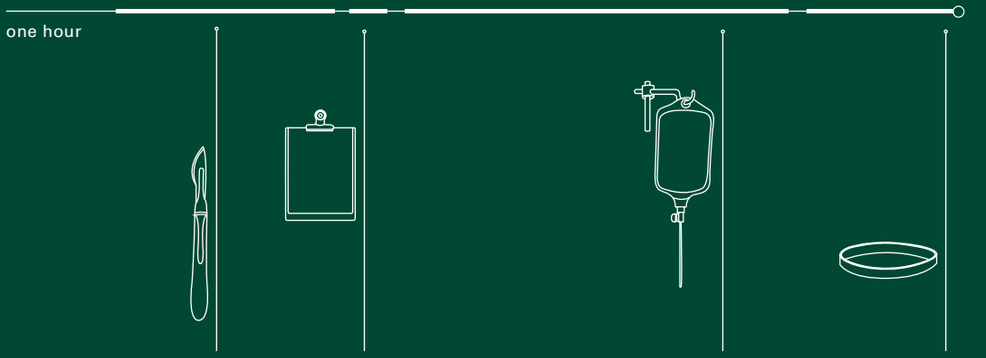
Acknowledging that the living human body is used as a source of materials is necessary to give direction to this topic within society. Due to ethical sensitivity, this discussion tends to be neglected, and thus results in a frequent absence of proper regulations within the field. A first step towards a utopian model of reusing unneeded human tissue is the creation of a space for people to discover the subject and form their own opinion about it. Corpus Commodus is an artistic expression of the potential of human tissue and our body's wide range of present opportunities—making visible a world that exists but is otherwise largely obscured.

Thresholds presents two sections of a larger volume.



Amniotic membrane

The amniotic membrane, or amnion, is the innermost layer of the placenta, which lines the amniotic cavity. The membrane itself is made up of a special combination of tissue which makes amnion a unique membrane in the human body. This membrane is comprised of cells that allow it to provide specific functions which aid in healing. Amniotic membrane can be donated only after the safe delivery of your baby by elective caesarean section. Usually, a caesarean section is performed when a vaginal delivery would put the baby's or mother's life or health at risk. Due to the physiological and histocompatibility characteristics of the amnion, amniotic tissue does not have to be directly matched with a potential recepient.



A caesarean section takes place under general or local anaesthesia. An incision in the abdominal wall and uterus is made and the baby is delivered. Donation of the amniotic membrane will not interfere with delivery of the baby.

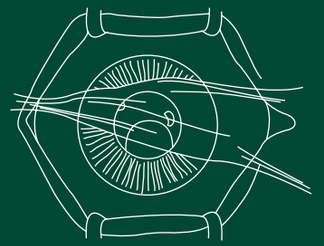
After delivery, an inventarisation of the medical history will be done and the consent form has te be side. Next to that, a blood sample of the mother has to be provided for testing

The post operative hospital stay might take a few days in which the urinary catheter is removed. If the baby is healthy, the baby can rest on on the chest of the mother and breastfeeding and bonding can start. Both will continually be monitored for any potential complications.

After delivery of the placenta, it is washed free of all blood clots and the amnion is separated from the rest by insicion. It is then processed and developed according to its future uses.

Consequences

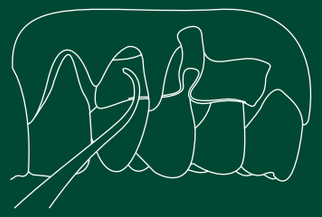
Hematoma in wound area	●	●	●	●	●
Nausea and vomiting first few days	●	●	●	●	○
Trembling due to the anaesthesia	●	●	●	○	○
Pregnancy not recommended for 18 months	●	●	●	●	●
Allergic infection due to anaesthesia	●	○	○	○	○
Wound infection	●	○	○	○	○
Thrombosis in leg veins	●	○	○	○	○
Pneumonia	●	○	○	○	○
Internal bleeding	●	○	○	○	○
Placenta obstetric complication	●	○	○	○	○
Fetal distress	●	○	○	○	○
Death of the child or mother	●	○	○	○	○



L.E.

Cornea replacement

Human amniotic membrane has been used for various types of reconstructive surgical procedures, including wide spread use in eye surgery. The basement membrane component of amniotic membrane is similar in composition to the conjunctiva and can be used as a permanent graft or overlaid graft. Used as a permanent graft, aim is to fill in the corneal tissue defect. When used as an overlaid graft, aim is to promote epithelial healing with minimal or no scarring.



L.E.

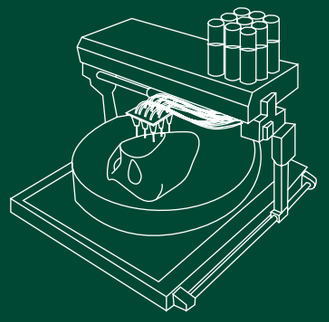
Dentistry application

Amniotic membrane is currently showing great promise in the area of dentistry to treat gum disease. The use of amniotic membrane allows the patient's own gum tissue to facilitate the growth of new cells and tissue to replace the tissue lost due to gum disease. Without the use of amnion, the patient is forced to have tissue harvested from his/her soft palate to replace the lost gum tissue. This procedure can be quite painful for the patient, making amniotic membrane a comforting alternative in surgery.

L.S.
L.E.

Skin graft

Another reconstructive surgical procedure that makes use of the amniotic membrane is the treatment for burned or alcerated skin in which it provides epidermal barrier functions. The epithelium in human amniotic membrane provides good protection from evaporative loss, as well as barrier function, whereas the fibronectin and collagen provide dermal function. It is transparent, which offers good wound surveillance capabilities, and is minimally adherent. However, it is difficult to obtain, prepare, and store and it must be changed frequently. Next to that, it has more significant potential for infectious disease transmission than other alternative products.



L.C.
L.S.
L.E.

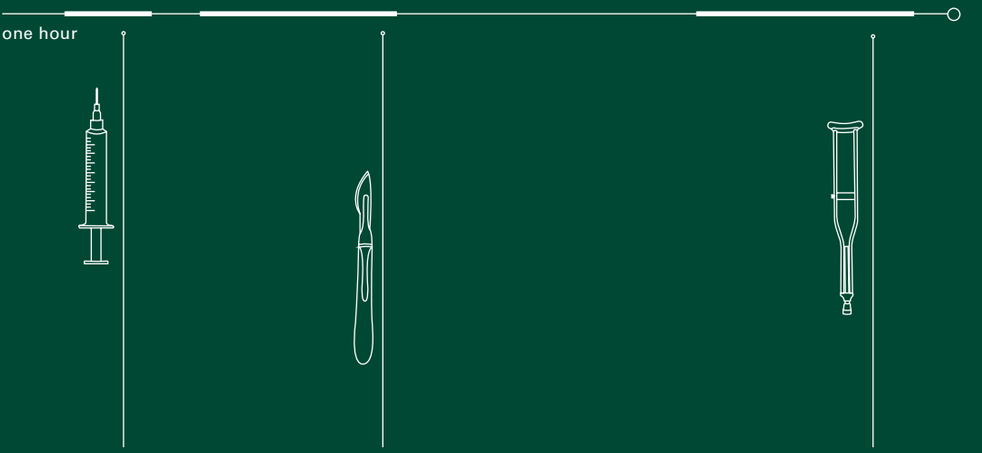
Tissue engineering scaffold

The amniotic membrane, due to its regenerative characteristics, could be used as a scaffold in cell development and tissue engineering. It could for example form the basic structures on which developed cell types are "printed" in order to form new organs or bodily tissues.

When giving consent for the donation of amniotic membrane after a caesarean section, the total amniotic sac becomes property of the hospital. Due to scientific development, further usage possibilities are not always known at the time of collection and storage. Cell material that has been extracted, can be processed, developed, researched and used in cooperation with the industry. In this way, it could even become profitable. Though, with the non-commercial principle in mind, the donor can never, even not when reducable or trace-able, claim any venues. This leads to cell lines being developed out of one individual donor's cell material, becoming worth loads of money that will never be shared with the donor and prior owner of the cells. Another result is hospitals throughout the world managing "closed market systems" in which collections of human body material are exchanged for laboratory equipment or other resources with commercial parties interested in the bodily materials.

Foreskin

Foreskin is a generally retractable double layered fold of skin and mucous membrane that covers the glans penis. It has a protection purpose but could be removed out of health or religious believes by a procedure called circumcision. It is a surgical procedure usually carried out with boys of a young age.



Penis and surrounding skin are desinfected with iodine while local anesthesia by injection at the base of the penis takes place

foreskin is being removed by cutting or clamping and the wound is stitched, this takes 20 - 30 min. After 1-2 hours, feeling in the penis will restore.

After a week a new layer of skin appears, though sports or swimming is only possible 2 weeks after the procedure.

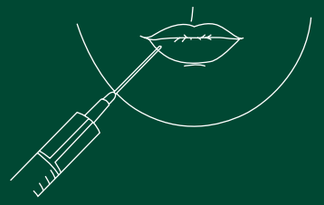
Consequences

Hematoma in wound area	● ● ● ● ●
Peeing is sensitive the first few times	● ● ● ● ●
Erection is painful the first few days	● ● ● ● ●
Glans is swollen, bruised and painful for a week	● ● ● ● ●
Sutures for a few weeks	● ● ● ● ●
Unable to practice sports within 2 weeks after surgery	● ● ● ● ●
No intercourse until the wound is healed	● ● ● ● ●
Wound infection	● ○ ○ ○ ○
	○ ○ ○ ○ ○
	○ ○ ○ ○ ○
	○ ○ ○ ○ ○
	○ ○ ○ ○ ○

C.D.

Facial cream

Foreskin contains fibroblasts. Fibroblasts are types of cells that synthesize the extracellular matrix and collagen, which forms the structural framework for human tissues. Next to that, they play a critical role in wound healing. The fibroblasts from the cells of the foreskin, can produce collagen in a lab. This collagen can be used in facial cream, pormising anti wrinkle effects.



C.

Liquid body filler

Microscopically small parts of tissue from circumcised foreskins could be developed and processed into a fluid resembling botox. The fluid is injected into the body underneath the skin to treat patients with aging lines, scars or sun affected skin.

L.S.
L.P.

Skin graft

Foreskin is used to create bio-skin grafts for burn victims, ulcers and other large-area open wound sites. Cells from the foreskin can be used to cultivate skin with a really small chance of rejection. The result after cultivation is a tissue that contains two types of cells. An outer layer of protective skin cells, and an inner layer of cells contained within collagen. Both types of cells contain substances similiar to those found in human skin. Therefore the tissue could play an active role in healing by providing the wound with living cells, proteins produced by the cells, and collagen while protecting it from infection.

Foreskin tissue has a huge potential as it can easily be cultivated to huge amounts of “material”. As an example, a piece of foreskin wth the size of a regular post stamp can be treated to grow to a size that resembles six football fields. This cultivated foreskin is processed into the first undustrial produced product, based on human material with consent from authorities. While in Europe it is still prohibited in usage, in the USA it is widely accepted. After the 9/11 attack, the total supplies of cultivated forskin were even donated to hospitals to treat the many burn victims.